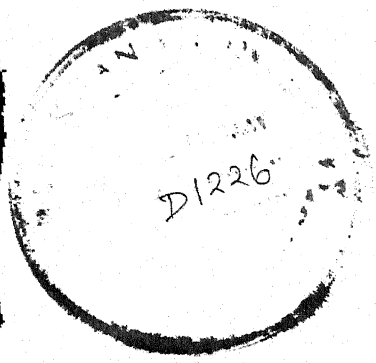
COMPARATIVE STUDY OF MANAGEMENT OF ANKLE FRACTURES, CONSERVATIVE VISA VIS INTERNAL FIXATION & EARLY MOBILIZATION

THESIS

FOR

MASTER OF SURGERY
(ORTHOPAEDICS)



BUNDELKHAND UNIVERSITY
JHANSI (U.P.)

2003

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CERTIFICATE

This is to certify that the work entitled "**COMPARATIVE STUDY OF MANAGEMENT OF ANKLE FRACTURES, CONSERVATIVE VISA VIS INTERNAL FIXATION & EARLY MOBILIZATION**" has been carried out by **Dr. Deepak Gupta**, himself in this department under my constant supervision and guidance.

The techniques embodied in this work were undertaken by the candidate himself. The results and observations were checked and verified by me periodically.

He has put in the necessary stay in the department as required by the regulation of Bundelkhand University, Jhansi.

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The techniques embodied in this work were undertaken by the candidate himself. The results and observations were checked and verified by me periodically.

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Deepak

DATED 6/8/02 DEEPAK GUPTA

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Introduction

INTRODUCTION

In ancient India- the Bharat- the sacred land of Shiva, Brahma & Vishnu, the feet have assumed a very special importance. Humbly, submitting with reverence and sincerity to the sacred feet of God, Goddesses and parents bring peace, happiness and sublimity to the soul. In all dances of India, classical to folk and those meant for the temples to court dancing halls, the role of feet has supreme importance.

Wood Jones has written "The feet is most distinct human part of whole anatomical make up, the hallmark which distinguishes him from all other members of the animal kingdom".

Achilles', as per Greek mythology, the son of Palesus and Thetis fought famous war of Trozan. To make Achilles' immortal and invulnerable, his mother dipped him in holy. River of Styx by holding both his ankle. That's how whole body of Achilles' became immortal, but his heels remained vulnerable point for injury. These vulnerable heels he always protected with strong shoes against injuries. It was this vulnerable heel which exposed him to death by arrow while he was kneeling in the temple of

Diana bare footed for worship. This is how the epitome "Achilles' tendon" was born representing one's weak point.

According to another myth, Talus, was a giant, last creature of bronze age who was given responsibility to save islands of crete. To make him immortal he was injected ichor in his vein just above ankle and nail was plugged in. But, while he was fighting with enemies, nail got struck to the rocks and ichor bleeded out of vein and Talus died.

This shows us, ankle as a soft target of ancient warriors. Compared with the hand, the foot and ankle has been grossly neglected by artists, by sculptors and by poets as well as medical authors. This may be the result of a mistaken impression that foot and ankle is much simpler than hand. Infact, it is much more specialized. If one doubts this, think of unfortunate people without hands, they may become foot and mouth artists. But no one have ever heard of anyone who without feet learned to walk on his hands.

The lower limb in its basic design is similar to the upper limb because formerly both of them (as in animals) were used for locomotion. However, with the evolution of erect posture in man, the two limbs despite their basic similarities have become specialized in different directions to meet the new functional stability. The emancipated upper limb is specialized for

prehension and free mobility where as lower limb is specialized for support and locomotion. In general, the lower limb attains stability at the cost of some mobility, and the upper limb attains freedom of mobility at the cost of some stability.

Ankle injuries are quite common for which an orthopaedic surgeon is often called upon. It causes, destruction, not only of the bony architecture but often of the ligamentous and soft tissue components. The joint comprises the distal tibia articulating surface, with extension on medial side as medial malleolus and the lower end of fibula as lateral malleolus. Together these structures form the ankle mortise which provides the stability as well as mobility to the ankle joint with the help of ligamentous structures.

The human ankle and foot are dynamic and complex mechanism of functionally interrelated parts, primary among which are bone, tendons and ligaments. Alteration in the anatomy of structure of one part significantly affect the function of other.

The basic function of foot in human is to provide support for ambulation, freeing the hands for dextrous activity. Though small in proportion to the rest of body, the ankle and foot must bear its entire body weight. Typically foot and ankle handles

approximately sixty three tonnes of stress with one mile of walking.

The weight borne by ankle joint of about one half square inch area is tremendous especially during running, jumping etc. However, the structures of foot by virtue of its special designing absorbs / disperses major portion of this energy. But failure of this mechanism of foot often result in disruption of ankle joint.

Ankle injuries occurs when load exceeds the capacity of the involve tissue to accommodate them. The abnormal loading environment is often difficult to judge, because of complex nature of forces involved.

Ankle injuries have been one of the difficult problems to tackle because the fractures that involve the joints ranked amongst the most serious with implication of pain, limitation of movements, instability and eventually secondary arthritis giving rise to prolonged morbidity and these complications are frequently attributed to inadequate reduction of the medial and lateral malleoli.

Only one mm of joint incongruity leads to forty two percent loss of joint contact area resulting in grossly increased contact pressure across remaining joint, is a factor contributing to secondary osteoarthritis, aside from gross anatomic incongruity

and instability. The need for accurate anatomical restoration is both obvious and essential.

Ankle injuries occur most commonly because of slipping and twisting of ankle, poor street lightening, defective roads, uneven surface in houses.

Road accidents, another major cause are increasing day by day due to rapid increase in automobiles. India, has one of the highest road accident rates in the world because of large number of old, poorly maintained vehicles, low driving standards and mixed traffic. Ankle injuries to foot and ankle has also increased due to increasing popularity of track and field sports.

None the less there is no uniform opinion regarding the best method of management of ankle fractures.

Various modalities of treatment available are as follows :-

1. Conservative treatment (Plaster of paris)
2. Compression screws (Malleolar or cancellous)
3. Plating (Semitubular or butress plate)
4. External fixator
5. Joint ablation technique (arthrodesis)

Pertaining to the controversy in method of treatment of ankle fractures and related complications, this study was undertaken to

analyse and understand the problems and clinical behaviour of these common and yet complicated ankle injuries and also to evaluate and compare the results of conservative and operative treatment in ankle fractures.

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ANATOMY OF ANKLE JOINT

The ankle joint is formed by the tibia, fibula and talus. The dome of the talus (trochlea) fits into mortise formed by the tibia and fibula. The medial and lateral malleoli projects downward to articulate with the sides of trochlea. The lateral malleolus projects down to the level of the subtalar joint considerably further than does the medial malleolus and thus provides greater bony stability for the lateral side of ankle joint. The ankle joint has sophisticated motion in three dimensions that results in plantar flexion and dorsiflexion of the foot. The bony arrangement also helps to promote anterior stability of the ankle joint so the tibia is driven forward on the planterflexed talus, the narrower part of tibia impinges on the widened anterior portion of talus, blocking forward dislocation of the tibia on the talus.

The relationship of the tibia, talus and fibula is maintained by three ligaments. These are the deltoid ligament, the lateral collateral ligament, and the syndesmosis. The deltoid is considered the strongest of the three ligaments and is so by necessity because of decreased bony protution medially.

The **deltoid ligament** is a broad, triangular band that has four parts as defined by their bony insertion on the navicular, calcaneum and talus. It is functionally divided into a deep and a

superficial portion. The deep portion attaches to the non articular part of medial talus and is horizontal, therefore resists lateral displacement of the talus.

The **lateral collateal ligament** of the ankle consist of three distinct parts.

a) The **posterior talofibular ligament** arises from posteromedial portion of the tip of the fibula and runs backward and slightly downward to attach to the lateral tubercle of the posterior process of talus. This ligament is the strongest of the three ligaments and helps to resist the forward dislocation of leg on the foot.

b) The **calcaneofibular ligament** is the largest of the three and passes inferiorly in a posterior direction to insert on the lateral surface of the calcaneum. It is lax in the normal, standing position owing to the relative valgus orientation of the calcaneum. This ligament is extracapsular but is intimately associated with the peroneal tendon sheath.

c) The **anterior talofibular ligament** arises from anterior border of the lateral malleolus and passes forward to attach to the neck of talus. It is the weakest of three ligaments and is taut in all positions of ankle.

The **syndesmosis** is the ligament that maintains the relationship of tibia and fibula. It consists of the anterior and

posterio tibiofibular ligaments and the interosseous membrane. The anterior and posterior ligaments arise from the anterior and posterior tubercles respectively, on the lateral side of the tibia. These ligaments actually hold the fibula snugly in a groove on the tibia, where fibula rotates about its vertical axis with dorsal flexion and plantar flexion of the ankle. There is three degree of rotation of the fibula laterally with dorsiflexion and three degree of medial rotation with plantarflexion.

The interosseous membrane runs between the tibia and fibula to the level of proximal tibio-fibular joint. It stablises the fibula, provides attachment sites for muscles and have some load bearing function.

IMPORTANT RELATIONS OF ANKLE JOINT

Anteriorly

Saphenous nerve and great saphenous vein

Superficial peroneal nerve

Tibialis anterior tendon

Extensor hallucis longus tendon

Anterior tibial artery with venae comitantes

Deep peroneal nerve

Extensor digitorum longus tendon

Peroneus tertius

Posteriorly :-

Tibialis posterior tendon

Flexor digitorum longus

Posterior tibial artery

Tibial nerve

Flexor hallucis longus

Sural nerve and small saphenous vein

Peroneus longus and brevis tendons

Tendo-achilles

Distal tibial and fibular growth :-

The distal tibial ossific nucleus appears between second and third year of life and fuses with the shaft at about the age of 15 years in girls and 17 years in boys.

The distal fibular ossific nucleus also appears at the second year and unites with the shaft by the age of 20.

Biomechanics of the ankle :-

The tibiotalar, talofibular and tibiofibular joints make up the ankle joint. The following anatomic considerations affect the function of the joint.

1. The medial malleolus is more anteriorly located than the lateral malleolus.

2. The superior surface of the talus is wedge shaped.
3. The medial malleolus extends about one third of the way down the medial surface of the talus and the fibular malleolus extends down almost the entire lateral surface.

Iman (1969) established the axis of rotation of the ankle joint as one that postero inferiorly from tip of the medial malleolus to tip of lateral malleolus. From the long axis of the tibia, this ankle axis forms an angle of 82 degrees in a coronal plane.

A functional range of motion for the ankle as seen in walking of the order of 10 degree of dorsal flexion and 20 degrees of plantar flexion. Wright used a mechanical unit with potentiometer acting as electrogoniometer and reported the following breakdown of one subjects functional ankle range in walking, 14 degree ankle rotation, 6 degree subtalar rotation and 5.5degree of toeing out.

Lambert demonstrated in a biostatic model that one sixth of the static load on leg was carried by a fibula. Ramsey focused on the tibiotalar joint and noted that there was $4.4cm^2$ of contact area in weight bearing neutral orientation. One mm of lateral talar displacement effectively reduce this area by 42 percent which is the equivalent of almost doubling the stress between the surfaces still in contact.

Movements of ankle joint :-

Barnard kleiger described the movement of ankle joint as follows :-

Dorsiflexion

That is the motion of the forepart of the foot in a cephalad direction on the transverse axis through the body of the talus.

Plantar flexion

Defined as the opposite motion through the same axis. These movements take place in part in the tibiotalar joint.

Lateral rotation

Defined as lateral direction of the forepart of the foot on a longitudonal axis through tibia.

Medial rotation

It involves a medial deviation of the forepart of the foot through the same axis. These motions takes place in part in the tibiotalar joint.

Eversion

It is accompanied by lateral rotation and displacement of heel on a longitudinal axis through the calcaneum.

Inversion

It is accompanied by medial rotation and displacement of the heel on a longitudinal axis. These movements normally take place in the subtalar and mid-tarsal joints.

Pronation

It is a combination of eversion of the foot, lateral rotation at the ankle and abduction of the forepart of the foot.

Supination

It is a combination of inversion of the foot, medial rotation at the ankle and adduction of the forepart of the foot.

Review of Literature

REVIEW OF LITERATURE

HISTORICAL REVIEW

Even before the invention of roentgenography much has been learned about the mechanism of injury to the ankle on the basis of clinical examination, and the laboratory production of experimental injuries in cadavers.

One of the first investigator Sir Percivall Pott (1714-1788) who in 1768 described a fracture of the fibula with in two or three inches of its lower extremity and lateral subluxation of talus. Since, neither malleolus was fractured, use of the term "Potts" fracture to indicate bimalleolar fracture should be avoided. He did, however emphasized the importance of accurate reduction which he achieved more easily by flexing the knee to relax the calf muscles.

After him the French dominated the field of ankle. Jean-Pierre David, was the first to explain the role of indirect or counter-coups forces in the production of ankle fractures.

Bromfeid (1773) and Fabre (1783) considered that abnormal motion of talus in ankle motion produced fractures of the malleoli. Posterior marginal fractures of the distal tibia were probably first recorded by Sir Astley Cooper (1822) which healed with posterior talar subluxation. Earle (1829) in Lancet

published the autopsy findings of a fresh posterior lip fracture. In 1840, Maisonneuve emphasized the role of external rotation of talus in the production of ankle injuries. He demonstrated in Cadaver that external torsinal force applied to the foot were determined by the strength of syndesmosis.

Hugunier (1848) demonstrated the importance of external rotation by showing that this force could produce a distal one third or proximal one third fibular fracture after ruptures of anterior tibio-fibular and deltoid ligament.

Tillaux (1872) described the lesions resulting from a combination of abduction and external rotation. He also observed, a small bone fragment from tibia (fragment troisteme). Wagstaffe (1875) recognized a rare type of fracture of anterior margin of lateral maleolus. Similar lesions were noted by Leforte (1886) and LeRoy (1887) they interpreted the mechanism as supination and abduction.

Nelaton (1874) described the fracture of the anterior articular margin of the distal tibia. Dupuytren (1877-1935) emphasized the role of inward and outward movements of foot in the production of ankle injuries, distinguishing fractures caused by ligamentous avulsion , which he believed to be the primary injury and those caused by talar impact, which he thought to be secondary one . He was first to describe the proximal intercrural

dislocation of the talus that might follow diastasis. This injury complex is known after his name.

Rochet (1890) documented the mechanism of production of posterior articular lip of the tibia by dropping a weight on the tibia while the ankle was held in plantar flexion. Destot (1911) named the posterior lip of tibia, the third malleolus.

FRACTURES OF DISTAL TIBIAL AND FIBULAR PHYSIS

Poland in 1898 made the first extensive study of physeal injury. Bishop (1932) studied the mechanism of physeal injury around the ankle. Aitken (1936) classified the distal tibial injuries. Carothers and Crenshaw (1955) observed that if physes get damaged then growth deformities occurs. Johnson and Fahl (1957) classified fractures of the distal tibial and fibular physis. Marmore (1970) described triplane fractures. Spiegel and associates (1978) studied the complication of epiphyseal injuries.

MECHANISM OF INJURY

Lauge-Hansen described injury mechanism in 1950. In his system, the position of foot at the time of injury is described first and direction of deformation force is described second.

1. **Supination Abduction :** As the foot supinates, the lateral structure tightens, continued supination and adduction may rupture portions of the lateral collateral ligaments or avulse them. Alternatively, the distal fibula may be avulsed,

resulting in a transverse fracture below the level of syndesmosis. Further adduction, drives the talus against the medial side of joint resulting in a vertical fracture of medial malleolus.

2. **Supination – External rotation :** The lateral structures and anterior syndesmotic ligaments tighten first. The anterior syndesmosis is usually injured with either rupture of the ligament or avulsion of its bony insertion. External rotation produces a spiral fracture of the fibula, which runs antero inferior to posterosuperior. Anterior syndesmosis is partially or completely disrupted. With continued force, the rotating talus may put tension on posterior syndesmosis, results commonly in avulsion of postero- lateral tubercle.

   Finally, if sufficient force remains, medial structure tightens, resulting in either an avulsion fracture of the medial malleolus or rupture of the deltoid ligament.

3. **Pronation-Abduction :** Medial structure tightens first, there is either avulsion fracture of the medial malleolus or rupture of deltoid ligament. Then abduction forces either ruptures syndesmotic ligaments or avulses their bony attachment sites. Continued lateral force from the talus, fracture the fibula at or above the level of syndesmosis.

4. **Pronation –External rotation :** Medial side is injured first. External rotation then results in rupture of the anterior tibiofibular ligament followed by fracture of the fibula at or above the syndesmosis. Fibular fracture is in spiral form from anterosuperior to postero inferior, and the interosseous membrane is ruptured. With continued force the posterior syndesmosis is also injured.

5. **Vertical loading :** It derives the talus into the distal tibia. It results in isolated fracture of the anterior or posterior lip of tibia or pilon fracture; according to the position of foot and rate of loading.

CLASSIFICATION

In 1922 Ashhurst and Bromer provided the first comprehensive classification of ankle fractures according to mechanism of injury.

The fractures were divided into three main groups : Abduction, adduction and external rotation fractures. In their series of 300 cases, majority were caused by abnormal movement of external rotation (60%), abduction (20%) and adduction (15%) of the talus in the ankle mortise. Rest of the 5% cases were anterior and posterior marginal fractures of lower end of tibia, 'T' and 'Y' type of fractures of tibia involving ankle and comminuted fractures of the ankle, which they included in fourth

category of fractures caused by compression force. Within each major group they distinguished three degrees of injury which they attributed to progressively increasing violence; first degree injuries involved only one malleolus; second degree injuries were bimalleolar or malleolar fracture and contralateral ligament rupture; and third degree injuries involved a fracture of the entire lower end of the tibia as well as the lateral malleolus.

This classification has the following limitations :

i) It fails to emphasize ligamentous damage sufficiently, especially in relation to diastasis;

ii) The third degree of injury in each group probably represents a different mechanism of injury rather than a progression in the severity of the injuring force;

iii) It suggests that ankle fractures are produced by a unidirectional force rather than a combination of forces, which is more often the case.

Many workers from the Scandinavian countries during this period used the term 'supination' and 'pronation' to describe abduction trauma and classified the injuries into supination fractures, pronation fractures and rotational fractures.

Bonnin's (1944) classification, a modification of Ashhurst and Bromer's classification was also later discarded.

Lauge Hansen in 1950 has provided the most useful and comprehensive classification based on the position of the foot and the direction of deforming force at time of injury, 98% to 99% ankle fractures can be fitted into his system.

According to Lauge Hansen classification

1. Supination – adduction

STAGE-I : Transverse fracture at lateral malleolus at varying heights or tear of the lateral collateral ligament.

STAGE-II : Stage I plus fracture of medial malleolus (vertical fracture)

2. Supination –External rotation

Stage-I : Disruption of anterior tibiofibular ligament

Stage-II : Spiral oblique fracture of distal fibula.

Stage-III: Disruption of posterior tibiofibular ligament or fracture of posterior malleolus.

Stage-IV: Fracture of medial malleolus or rupture of deltoid ligament.

3. Pronation – Abduction

Stage-I : Transverse fracture of medial malleolus or rupture of deltoid ligament.

Stage-II: Rupture of syndesmotic ligament or avulsion fracture of their insertion.

Stage-III: Short, horizontal oblique fractures of the fibula above the level of the joint.

4. Pronation- External rotation

Stage-I: Transverse fracture of medial malleolus.

Stage-II: Disruption of anterior tibiofibular ligament.

Stage-III: Short oblique fracture of fibula above the level of the joint.

Stage-IV: rupture of posterior tibiofibular ligament or avulsion fracture.

5. Pronation- Dorsiflexion

Stage-I: Fracture of medial malleolus.

Stage-II: Fracture of anterior margin of tibia.

Stage-III: Supra malleolar fracture of fibula.

Stage-IV: Transverse fracture of the posterior tibial surface.

About three fourths of Lauge-Hansen's cases fell into the first two groups (i.e. occur with the foot inverted, which reflects the inclusion of sprains of the lateral collateral ligament.

It is of interest that the lesion produced by external rotation varied with the position of the foot; with external rotation of the supinated foot the first injury on the lateral side of the ankle, whereas with external rotation of the pronated foot, the first injury was to the medial structures. External rotation produced extensive damage to the syndesmotic ligaments only when the foot was pronated. Also, fracture of the posterior lip of the tibia involving more than a small portion of the articular surface of the tibia required vertical compression in addition to external rotational forces, whereas small posterior lip fractures were avulsed by the posterior tibiofibular ligament as result of talar rotation in the mortise.

In Lauge-Hansen's classification the different types of injuries can readily be differentiated by means of the nature of the fibular fracture which is characteristic of each type. It is based on experiments on cadaver and is very much useful in pathogenetic understanding of ankle injuries by indicating the relationship of ligamentous damage of fracture patterns and the sequences in which different structures are damaged when specified forces are applied; however it is unnecessarily detailed and cumbersome for routine use in manipulative reductions.

Jergesen in 1959, advocated a more simplified classification...

1. External rotation – eversion and abduction injuries:

a) Medial side

i) Transverse avulsion fracture of the medial malleolus

ii) Ruptured deltoid ligament

b) Lateral side

i) Spiral fracture of the lateral malleolus with the fracture line preceeding from the distal anterior to the proximal aspects (external rotation).

ii) Spiral fracture of the shaft of the fibula above the syndesmosis usually associated with disruption of the syndesmosis (external rotation).

iii) Short oblique fracture of the fibula in the mediolateral plane below or above the syndesmosis, often with a small lateral butterfly fragment at the fracture (abduction).

c) Syndesmosis

i) Torn anterior tibiobular ligament (external rotation) through a complete syndesmosis rupture (more common abduction mechanism).

ii) Avulsion fracture of the posterior malleolus (external rotation).

2. Adduction- inversion injuries

a) Medial side

i) Oblique fracture of the medial malleolus extending from the corner of ankle mortise proximally and medially.

b) Lateral side

i) Transverse avulsion of the lateral malleolus below the syndesmosis.

ii) Rupture of the lateral collateral ligaments.

c) Syndesmosis

i) As part of a fibular fracture (torn inferior fibres rare in adduction injuries).

d) Posterior malleolus

i) With postero-medial dislocation (occasional fracture of the posterior and medial malleoli)

In recent years much more attention has been focussed on the lateral malleolus as a significant weight bearing structure in addition to being the lateral buttress for the ankle mortise. Studies have shown that during the stance phase of gait upto 20% of the upward force is absorbed by the lateral malleolus, and thus more frequent rigid internal fixation of this structure is indicated, even small alterations in the position of the lateral

malleolus with tilting or shortening can markedly distort the talotibial weight bearing area and lead to rapid degenerative arthritic changes within the ankle joint. If a congruent ankle joint is to be maintained, the mortise must have normal width. Even a small malposition of the lateral portion of the tibiofibular articulation will lead to abnormal wear. For the mortise to function satisfactorily the fibula must be :

1) Normal in length

2) Correctly positioned in the groove of the tibia, and

3) Effectuively anchored to the tibia through the syndesmosis.

The Denis Weber classification (1966) also recommended by AO (Arbutsgeneinschaft fur osteosynthes) emphasizes the fibular fracture, pointing out that the higher the fibular break the greater the syndesmosis injury and displacement of mortise.

The three types of fracture are as follows :

Type-A: Caused by internal rotation and adduction is a transverse fracture at or below the joint line, with a possible shear fracture of medial malleolus.

Type-B: Results from external rotation, which produces a fracture rising obliquely from the joint line in antero posterior plane and associated medial injury.

Type-C: Fracture are divided into

C1 : Resulting from abduction alone which cause an oblique medial to lateral fibular break above ruptured tibio-fibular ligament.

C2: Resulting from combination of abduction and external rotation, where in more extensive syndesmotic rupture occurs.

All types may occur with posterior malleolus fragments, either large or small.

According to **AO classification**

Type A : Fibula fracture below syndesmosis

A1 Isolated

A2 With fracture of medial malleolus

A3 With posteromedial fracture

Type-B: Fibula fracture at the level of syndesmosis

B1 Isolated

B2 With medial malleolus

B3 With medial lesion and fracture of posterolateral tibia.

Type-C: Fibula fracture above syndesmosis

C1 Diaphyseal fracture of fibula, simple

C2 Diaphyseal fracture of fibula, complex

C3 Proximal fracture of fibula

DIAGNOSIS

CLINICAL EXAMINATION

Bostrom (1965), Cedell (1975) and others have stressed the importance of clinical examination. The foot, ankle and calf up to knee should be palpated for tenderness or deformity or both. Specifically the course of deltoid ligament and the individual lateral ligaments of the ankle, the malleoli, the anterior and posterior tibiofibular ligaments, the entire length of fibula, the anterior and posterior margins of the tibio-talar joint, the sinus tarsi, the peroneal tendons and the achilles tendon should be palpated. The active range of motion of the ankle should be recorded. Pedal pulse should be palpated, and sensory and motor function should be assessed (Dobner and Kersy 1985).

Hopkinson (1990) described that compression of the fibula against tibia at the midcalf level elicits pain near the ankle when the syndesmosis has been injured. The commonly used clinical stress tests for evaluation of lateral ligament laxity of the ankle are the talus in relation to the tibia, is known as the anterior drawer of the ankle. The anterior talofibular ligament is the primary restraint in the anterior drawer test. Talar instability is also assessed with the talar tilt test, in which the angle formed by the tibial plafond and the talar dome is measured as an inversion force is applied to the hind foot. This test is useful for evaluation of combined injury of both the anterior talofibular and

the calcaneofibular ligaments. Dijk et al (1996) described the method of clinical examination and reported that it is sufficient to diagnose sprained ankle.

RADIOGRAPHIC EXAMINATION

Bonnin (1944) described the radiographic examination and emphasized that it should be performed in well-defined and reproducible projections. Both ankles should be examined for evidence of old injuries, incongruity in the joints between the talus and the malleoli, or widening of the ankle mortise. The radiographs are generally taken in four views:

- Antero-posterior view
- Lateral view
- Bimalleolar view (Mortise view)
- Oblique view

Anteroposterior view in 10° of internal rotation of leg gives good view of the joint space and specially the space between the talus and medial malleolus (Boninn, 1944).

The lateral view is taken with the lateral border of the foot resting on the cassette. Mann (1992) told that it assesses the ankle for effusion, talcalcaneal relationships, tibiofibular integrity, and tibiotalar joint congruity.

Bonnin (1950) described Bimalleolar view (Mortise view) which is taken in 30° of internal rotation of the leg as a result of the X-rays pass paralled to the plane of inferior tibiofibular joint and the later is better visualized in this view.

An oblique view, a special view, may be needed to distinguish an oblique spiral fracture of fibula and posterior marginal fracture of tibia. This view is taken in the lateral position of the foot and the central beam of X-rays directed from 30° cephalad and posteriorly. The external oblique view primarily adds information about the medial malleolus.

TREATMENT OF FRACTURES AROUND ANKLE JOINT

CONSERVATIVE VISA VIS OPERATIVE TREATMENT

The treatment should be based on a clinical determination of stability. For the mortise to function satisfactorily the fibula must be (1) normal in length (2) correctly positioned in the groove of tibia and (3) effectively anchored to the tibia through syndesmosis.

There are four criteria that must be full filled for best functional results in the treatment of ankle fractures given by Michal W. Chapmen (1992).

1. Dislocations and fractures should be reduced as soon as possible. Reduction is easier to obtain before swelling occurs and before the fracture hematoma between the fragments

organized. Furthermore, gross displacement particularly in the ankle, subtalar and midfoot joints- results in considerable distortion of the soft tissues and can lead to impairment of peripheral circulation, neuropraxias and loss of skin. Early reduction minimizes these complications

2. All joint surfaces must be precisely reconstituted- non anatomic reduction may lead to joint instability and/or joint surface incongruity which predisposes to arthritis.

3. Reduction of the fracture must be maintained during the period of healing. Once anatomic reduction has been achieved, it must be held until healing of bone and ligaments sufficient to provide stability has occurred. This can be accomplished by external immobilization with a plaster cast or splints, by external fixation, or by internal fixation.

4. Motion of joints should be instituted as early as possible. To maintain itself in a state of health, any organ or organ system must be used. Suppression of the normal functioning of the musculoskeletal system by immobilization of any of its parts is attended by numerous undesirable sequelae, including muscular atrophy, myostatic contracture, decreased joint motion, poliferation of the connective tissue in the capsular degeneration and bone atrophy. Furthermore, vascular changes occur during the period of immobilization and these often result in edema after the external support is removed.

The aim of the treatment of ankle fractures in the restoration of normal function, which is best accomplished by exact anatomic restoration and the maintenance of this reduction until healing is complete (Bohler 1923, Vasli 1957, Jergesen 1959, Cedel & Wisberg 1962, Burwell and Charnley 1965, Muller 1979). Exact anatomical reduction in displaced ankle fracture is often obtained and maintained by operative mean than by conservative methods. Recent workers have applied conservative treatment only for undisplaced and stable fractures.

Scandinavians have accepted surgical intervention as being the most effective means of restoration of joint anatomy, while in north America and at other places, many workers think that a primary attempt at closed reduction should be made before operative interference is considered.

(Dans 1949, Hohman 1950, Vasli 1957, Willengge and Weber 1963, Denham 1964, Cedell 1967) employed operative treatment for every injury, as their opinion, conservative treatment does not allow satisfactorily joint reconstruction.

AO group surgeons (1966) aim at a totally stable joint reconstruction and at a post operative treatment without immobilization in plaster.

Cedell (1975) found the frequent cause for failure in conservative method of treatment is interposition of soft tissue, cartilage and bone fragments.

Rowly, Norris and Duckworth (1986) done a prospective comparing of operative and manipulative treatment of ankle fractures. They reported that if a good reduction can be achieved and maintained then closed treatment is as good as operative treatment in short time and seemed to result in a quicker return to normal gait.

Chapman (1992) reported that the accuracy of alignment is much more important on the lateral side as compared to medial. Upto 2mm of displacement of the malleoli and 1 to 2 degrees of talar tilt are compatible with a satisfactory resuts.

METHODS OF TREATMENT

1. Fracture without displacement

The treatment only required is immobilization in a POP cast till the union of the fracture is obtained.

In stable injuries such as unimalleolar fracture without contralateral ligament ruptures, most authors prefers a below knee POP cast for about six weeks.

However, unstable injuries such as bimalleolar fracture or unimalleolar with contralateral ligament ruptures require

immobilization in long leg cast extending from groin to the toes till the union is firm (Yablan 1981).

Recently, many workers specially AO group surgeons, have advocated surgical treatment for undisplaced but unstable ankle fractures.

1. Fracture with displacement

Mainly three method of treatment are available ;

1. Closed reduction and plaster immobilization.
2. Traction through calccaneum.
3. Open reduction and internal fixation.

Kristensen (1956), Klossner (1962), Hughes et al (1979), Duckworth (1986), reported satisfactory result with conservative management in Weber type A and type B fracture if reduction maintained.

Calcaneal traction is mainly used in comminuted fractures of the tibial plafond (Cox and Caoxson 1952).

Barnard Kleiger 1961, Soloman 1965, Colton 1971, Hughes 1979 found better results in the fractures treated surgically. They also found that most of the supination_-external rotation and pronation- external rotation fractures required surgery.

INDICATIONS FOR OPERATIVE INTERVENTION

Bohler 1954 gave following indications for surgical intervention :

1. Attached ligaments preventing a small fragment from opposition from the main fragment.
2. Interposition of soft tissue at the fracture site.
3. Interposition of some bony fragment at the fracture site preventing accurate reduction.
4. Interposition of tibialis posterior tendon or medial ligament between medial malleolus and talus or in medial malleolar fracture line.
5. Upper fragment of fibula caught behind the lower end of tibia.
6. Twisting or tilting of medial malleolar fragment.

Denham (1964) suggested operative treatment in all the displaced second and third degree fractures. David Segal (1979) recommended internal fixation in unstable ankle fractures where there was bony or combined bony ligament injury and where talus is displaced by 2mm or more.

MW Chapman (1992) gave following indications for surgery:

1. Fractures of one malleolus: If it is associated with ligamentous injury or if the patients is young. Fractures at the level of ankle joint.
2. Bimalleolar fractures and fracture dislocation.
3. Trimalleolar fracture and fracture dislocation.
4. Fracture of anterior lip of distal tibia.
5. Fracture with severe communition and instability.
6. Repair of ligament ruptures.
7. Fractures of lateral malleolus with posterior displacement of proximal fibular fragment.
8. Open fractures and fractures- dislocation of the ankle.

OPERATIVE TECHNIQUE

1. **Fractures of medial malleolus :**

The commonest method of fixation is screw (Muller 1945, Mitchell and Fleming 1959, Burwell and Charnley 1965). When the medial malleolar fragment is very small excision of this fragment with repair of deltoid ligament was done by Portis and Mudilson (1953). Recently workers are recommending AO technique of rigid internal fixation.

2. Fractures of fibula

Cedell and Wiberg (1962) paid attention to the necessity of a careful reconstruction of the injuries of the lateral malleolus a view advanced by Danis as early as 1949. New observations have proved that even minute rotation and displacements of lateral malleolar fragments by displacing the vertical axis of the talus give rise to a considerably reduced contact surface between the tibia and the talus. Thus the precise fit between the articular ridge of the tibia and the corresponding articular groove of the talus cannot be disturbed without leading to incongruity, dysfunction and arthrosis deformans.

Recently work by Lambert (1971) and Ramsey and Hamilton (1976) has given scientific basis for the importance of the lateral malleolus fixation and its function in carrying out the stabilization of ankle mortise.

Yablon, Heller and Shouse (1977) reported the results of primary stabilization of the lateral malleolus is of paramount importance in obtaining anatomical restoration of the displaced fractures of the ankle involving both the malleoli.

Various forms of internal fixation technique and devices may be used. Circumferential wiring was employed in long oblique fractures by Vasli (1957) but condemned by Charnley (1957). Oblique and spiral fractures whose lengths are greater than 1½

times the diameter of the bone at the level of the fracture are best fixed wih interfragmentary lag screws. Neutralisation of the forces across the fractures should always be accomplished by one third fibular plate applied to the lateral border of fibula.

The AO tension band wire technique is useful to transverse fracture (Weber type A) at or below the syndesmosis.

3. **Fractures of posterior malleolus :**

It is mostly agreed that fractures of the posterior malleolus involving more than 25-30% of the tibial articular surface should be internally fixed if they are displaced. Burwell and Charnley (1965) advocated the use of two screws but according to AO technique, posterior malleolus is rigidly fixed by means of compression lag screw from anterior to posterior.

Huber, Stutz and Gerber (1996) found that open reduction and internal fixation of the posterior malleolus with a posterior antiglide plate using a postero-lateral approach gives better anatomical reduction and stability than the AO/ASIF technique of antero posterior lag screw.

4. **Syndesmosis injury :**

Many workers have reported internal fixation of the inferior tibio-fibular syndesmosis essential for treatment of diastasis. Commonest method to fix the diastasis of the joint is the use

of a screw across the syndesmosis (Bonin 1950, Mayer 1956; Vasli 1957).

Burwill and Charnley (1965), however hold the opinion that transyndesmotic fixation is not essential when the associated fracture have been fixed.

Colton (1968) described that a screw should be directed upwards, forwards and medially.

Hugh R Chissell, J Jones (1995) recommended that when the deltoid ligaments is ruptured a diastasis screw should be used in the fibular tibial plafond.

TIBIAL PILON (PLAFOND) FRACTURES

Most workers presently believe that even in severely comminuted fractures of the tibial plafond, attempt should be made to achieve anatomic restoration of the joint surface as much as possible to achieve best results. Howell (1975); Robert (1979) advocate internal fixation of all the fragments with whatever the device may be suitable depending on the size and site of various fragments. Muller et al (1979) also advocate total reconstruction of comminuted fractures with multiple fixation devices, including large buttress plates, to stabilize the shaft component and permit early mobilization.

TREATMENT OF COMPOUND FRACTURES

The same principles of meticulous debridement, copious irrigation and the use of systemic and local bactericidal antibiotics apply to open fractures of the ankle as apply to open fractures and injuries elsewhere in the body. Open fractures of ankle are commoner because bones are superficial (Watson Jones, 1955 and Conwell 1961). Chapman and Mahoney (1976) found that 60% of open ankle injuries had type I wounds and only 10% had type III wounds.

Injuries closed within 6-8 hours may not get infected. Cut tendons and nerves should not be repaired primarily unless it is sure that infection will not occur, secondary repair may be carried out after the wound has healed (Watson-Jones 1955). Joint closure, as either primary or a delayed primary procedure is essential (Jergesen 1959). The skin wound can be closed by primary closure, delayed primary closure, or secondary closure-depending on the degree of soft tissue damage and contamination and on the amount of elapsed time since occurrence of the injury (Edwards 1965). There is difference of opinion regarding the internal fixation in compound fractures. Edwards (1965), Burwell (1971), Olerud (1972). Gregory (1975) have emphasised the role external fixator in such injuries.

Chapman and Mahoney (1976), found in their patients that if immediate fixation was achieved, the infection rate in type I

wounds was two percent in type II wounds eight percent, in type III wound, 29%. This is significant insofar as it means that immediate internal fixation of ankle with type I wounds can be performed without an infection rate greater than that seen in closed fractures.

Wiss et al (1989) in 76 open ankle fractures treated by immediate internal fixation had only a five percent deep infection rate. Twenty eight of their 76 fractures had grade III wounds. They suggested that primary internal fixation of ankle fractures can be carried out with acceptable risks.

COMPLICATIONS

Malunion : It may occur at any of the malleolar fracture sites and is often responsible for the later clinical deformity. Malunion predispose to degenerative arthritis of the ankle.

Nonunion : This complication in commonly encountered in transverse avulsion fractures of malleoli specially medial malleolus at the level of joint (Magnusson, 1944, Klossner 19620. Otto Sneppen 1969) noted psuedoarthrosis of medial malleolus.

Infection : This may follow either open fractures or the open treatment of closed fractures. The reported incidence varied from 1% to 18% in the latter group.

Joint stiffness and persistent edema : This is common complication specially in cases treated by closed method as reported by Watson Jones (1955) and Burwell and Charnley (1965).

Post traumatic arthrosis : Burwell and Charnley (1965), Yablon (1977), Magnusson (1965), Cedell (1971) reported this complication in 20% to 40% of ankle fractures regardless of method of treatment.

Sudeks's Osteodystrophy : A form of reflex sympathetic dystrophy. This is characterized by pain, early patchy demineralization, edema, cyanosis, a tout, shiny skin which is hypersensitive and a markedly diminished range of motion.

Synostosis : Ossification of the interosseous membrane may follow injuries to the syndesmosis.

Trapping of the tibialis posterior tendons : Coonard, Bugg and Durham (1954), Parrish (1959) reported this complication and is the unusual cause of inability to reduce lateral fracture dislocation of the ankle joint.

* * * * * *

Material and Methods

MATERIAL AND METHODS

The study was conducted in the department of Orthopaedics, M.L.B. Medical College, Jhansi. The study included patients admitted after presenting at OPD or emergency. The cases of undisplaced fractures were treated as out patients while the patients who required operative treatment were admitted to the hospital.

All the patient of ankle injuries were studied as per proforma enclosed between May 2000 to July 2002. On arrival of patients to hospital, patients was resuscitated from shock, bleeding, if present and POP slab. Any compounding was managed by irrigation and debridement.

In cases with some delay specially with marked swelling, the presence of any blisters or skin necrosis was looked for. Neurological examination, examination of peripheral pulses and nail bed circulation was done in all the cases to exclude any neurological deficit.

Anterior posterior and lateral skiagrams of the injured ankle were taken in all the cases. Routine investigations such as hemoglobin, total and differential leukocyte count, ESR, blood sugar, blood urea and routine urine examination was done in the mean time.

After thorough study of X-ray, patient fitness to anaesthesia, economic condition of patient decision was taken whether he or she is to be operated or not.

MANAGEMENT

In unimalleolar fractures a below knee plaster cast was given in all cases. Immobilization was continued for a period of 6-8 weeks. Plaster immobilization was discontinued only when there was clinical and radiological evidence of fracture union. Many patients who complained of recurrent oedema around ankle after the removal of cast were advised to used a crepe bandage during the day and elevation of the extremity during the night.

FRACTURES WITH DISPLACEMENT

All the displaced fractures were treated either by manipulative reduction and plaster immobilization or by open reduction and internal fixation.

If the radiograph showed unsatisfactory reduction, an open reduction and internal fixation was taken. In unstable fresh fracture open reduction and internal fixation was done. All operations were performed under general anaesthesia, spinal anaesthesia or epidural block with tourniquet.

MEDIAL MALLEOLUS

After exposing the fracture site by antero medial or postero medial approach, two K-wires were drilled at right angles to the plane of the fracture. Each K-wire was then

removed and replaced with 4.5mm malleolar or cancellous screw.

LATERAL MALLEOLUS

After exposing the fracture site by anterolateral or postero lateral approach, oblique and spiral fracture were fixed by interfragmentary screw and one third tubular plate along the lateral border of fibula.

The transverse fractures were fixed by AO tension band wire technique.

POSTERIOR MALLEOLUS

Was reduced by the same incision given to expose fibula and fixed by means of compression lag screw from anterior to posterior.

SYNDESMOSIS

Syndesmosis separation that were unstable were fixed by cortical screw after fixing the fibula fracture first.

POST OPERATIVE MANAGEMENT

After fixing the fracture the limb was kept in below knee slab and limb elevated with active toe movement.

The stitches were removed after twelve days and slab was replaced by below knee cast and patients were advised non-weight bearing walking for 6-8 weeks. Plaster immobilization was discontinued when there was clinical and radiological incidence of fracture union. Thereafter the patients were

instructed to do active physiotherapy and to bear weight within the limits to discomfort gradually resuming full weight bearing.

TREATMENT OF COMPOUND FRACTURES

In compound injuries meticulous debridement, copius irrigation, and the systemic and local antibiotics were used and in most cases the fractures were fixed with K-wire, tension band wiring or rush nail.

FOLLOW-UP

Patients were followed up according to plan given in the proforma. While grading the results of treatment of these injuries the criteria suggested by Klossmer (1962), Olerud and Molander (1984) and D.Seagal (1985) were used.

CLINICAL CRITERIA

(a) Subjective criteria

Good results : Complete recovery slight discomfort or aching after use.

Fair results : aching during use, slight stiffness not enough to interfere with normal activity. Ability to walk, not seriously impaired.

Poor results : Considerable permanent handicap, serious impairment or ability to walk, pain.

(b) Objective criteria

Good results : Normal; gait, slight swelling and ankle and foot movement at least ¾th of the normal range.

Fair results : Normal gait, no deformity, some swelling , ankle and foot movements at least half of the normal range.

Poor results : Obvious limp, visible deformity of ankle or foot, movement of ankle and foot less than half of the normal range.

(c) Radiologic criteria

Good results :

Lateral malleolus: Anatomic alignment or upto 1mm displacement in any direction, minimal mortise widening (less than 0.5mm).

Medial malleolus : Less than 2mm displacement in any direction. Mortise widening less than 0.3mm.

Posterior malleolus : Less than 2mm displacement.

Talus : Less than 0.5mm displacement in any direction.

Early mild arthritic changes were graded in this group.

Fair results : When the above mentioned displacement ranged between 2.5mm or widening of

tibiofibular syndesmosis less than 2mm patients with mild arthritis changes are included in this category.

Poor results : Above mentioned displacement being more than 5mm. Mortise widening of more than 2mm. Residual talar displacement cases with severe arthritic changes were included in this group.

PROFORMA FOR THESIS

Name M.R.D. No.

Age/Sex Ward/Bed

Occupation Diagnosis

Address C/I

Date of injury

Date of attending to injury

Mode of injury- Sport injury

Slipping and twisting injury

Road traffic accident

Fall from height

Others

Present history

Treatment history

(Patient had taken any treatment before reporting to the hospital)

Personal history

Past history

Family history

Initial status of patients

Vitals

- Pulse rate
- Blood pressure
- Respiration
- Temperature

General examination

Systemic examination

Local examination

- Deformity
- Swelling
- Closed /open
- Tenderness
- Movements at the ankle joint
- Abnormal mobility and stress examination
- Stability of ankle joint
- Neurovascular status
- Other associated injuries

Radiological examination

Anterior posterior view

Lateral view

Mortise view

Stress view

Routine investigation

Blood Hb, TLC, DLC, ESR

Urine (Routine and Microscopic)

Classification of injury according to Lauge-Hansen.

1. Adduction injuries (Supination-adduction)

   Stage I

   Stage II

2. Supination –External rotation injuries

   Stage I

   Stage II

   Stage III

   Stage IV

3. Abduction injuries (Pronation-abduction)

   Stage I

   Stage II

   Stage III

4. Pronation-external rotation injuries

Stage I

Stage II

Stage III

Stage IV

5. Vertical compression (Pronation-Dorsiflexion)

6. Uncommon unclassifiable injury patterns.

Diagnosis

Treatment

Conservative

Operative

Post operative X-ray

Follow up

First week - Swelling

Infection

Neuro vascular status

Pain

Second week- only in operative cases

Six week - Discomfort

Pain

Swelling

Recurrent edema

Gait

Movement at ankle joint

Twelve weeks- Muscle atrophy

Non union

Delayed union

Mal union

Other complications

Results :

* * * * * *

Photographs

CASE SERIES – I

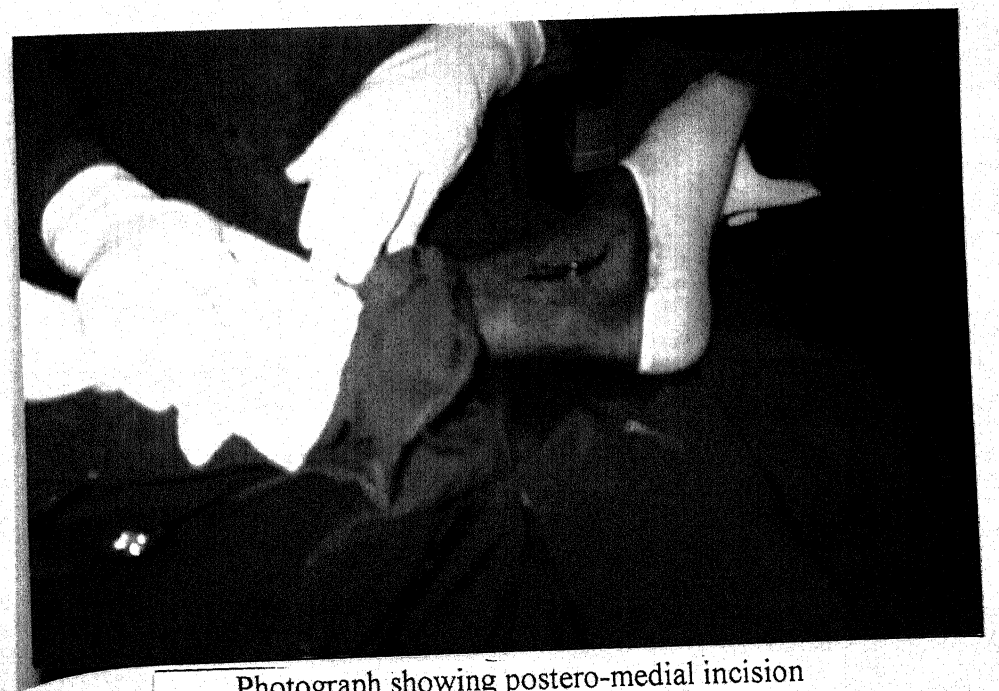
X-ray showing displaced bimalleolar #

Post-op. X-ray showing fixation of medial malleolus by two malleolar screw

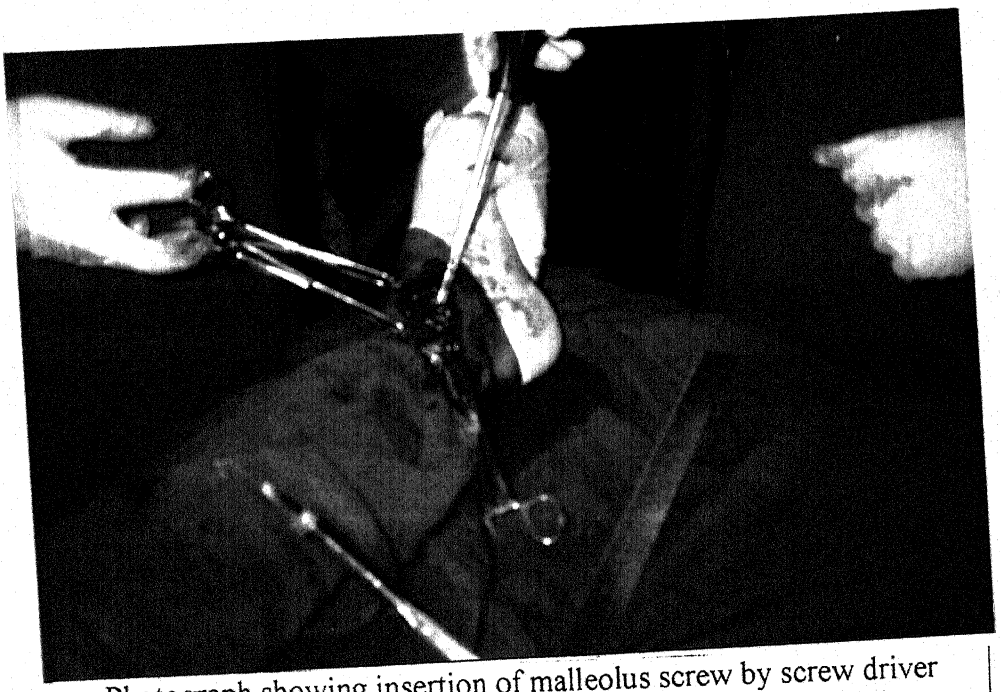
Photograph showing swelling over lateral aspect of ankle

Photograph showing swelling over medial aspect of ankle

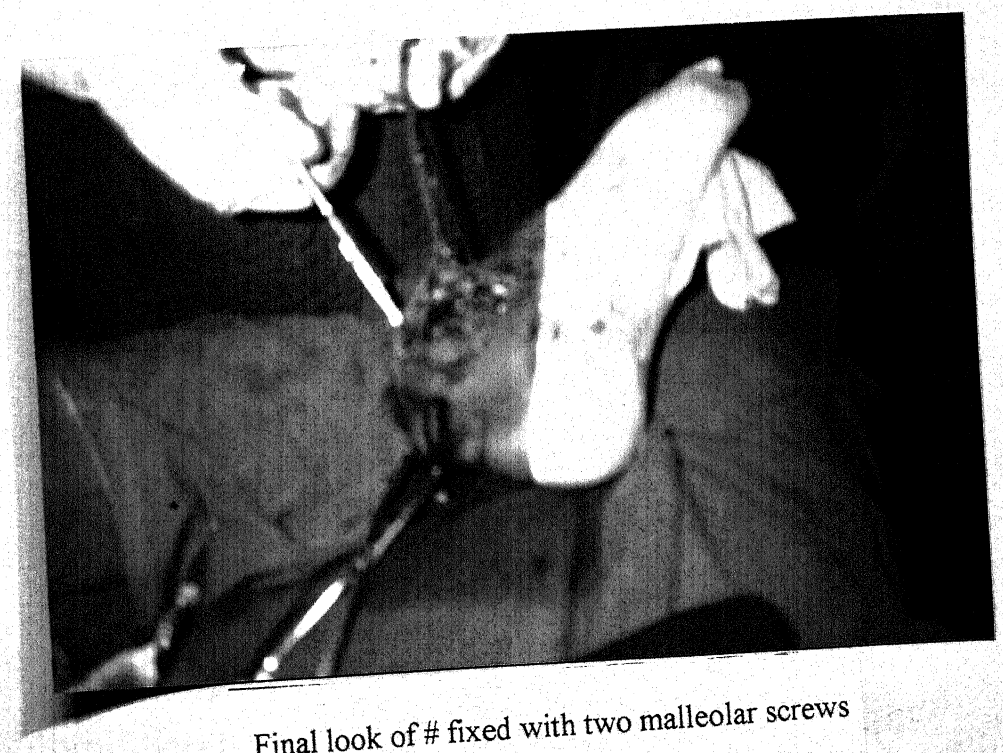
Photograph showing painted and draped ankle and foot



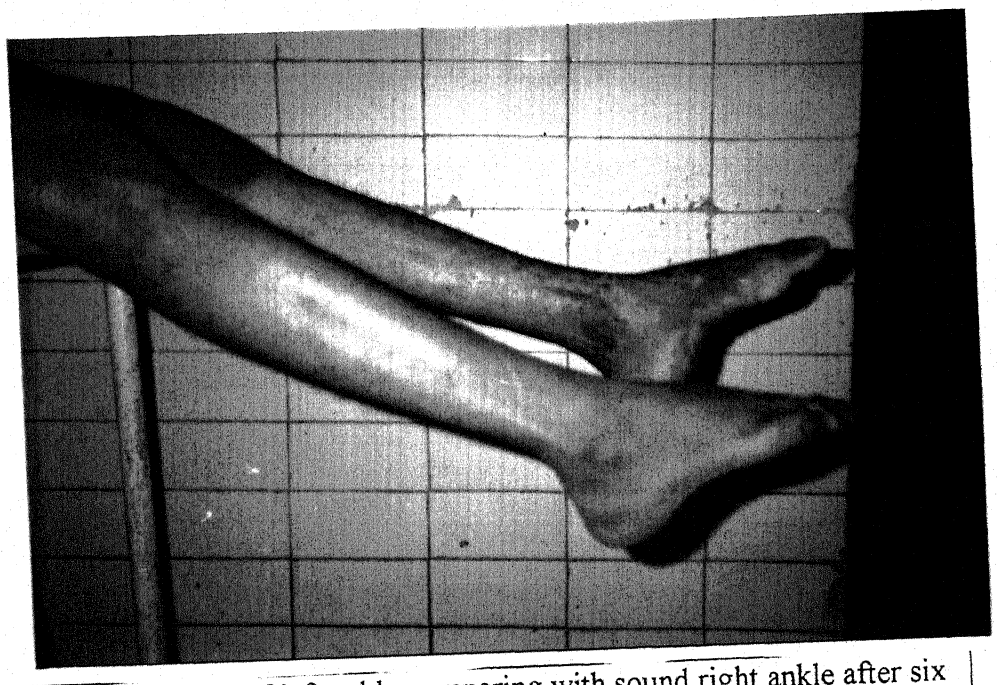
Photograph showing postero-medial incision



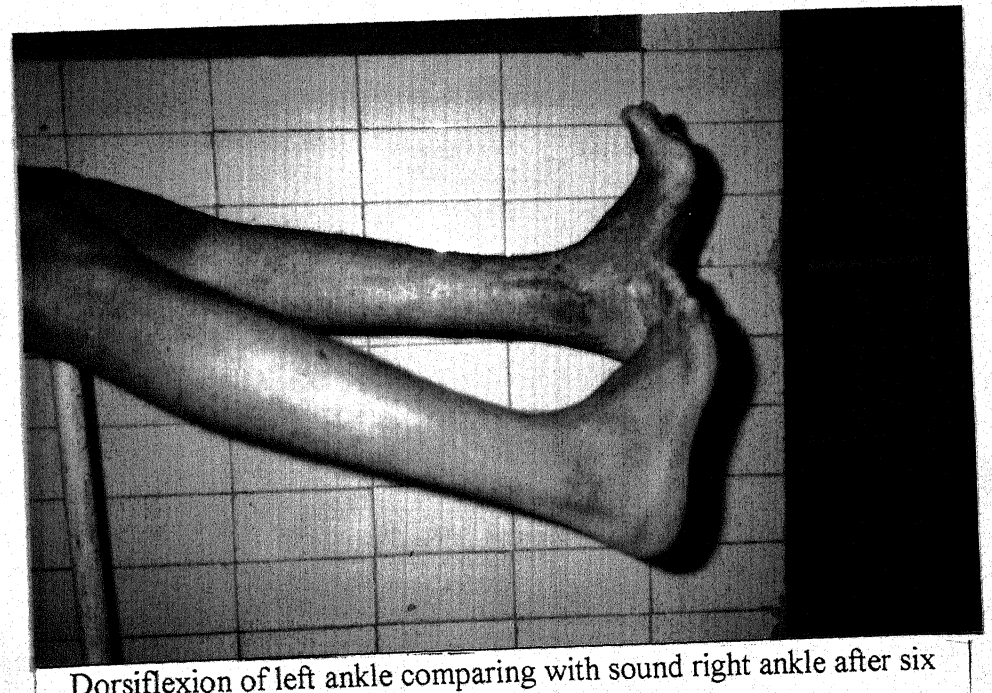
Photograph showing insertion of malleolus screw by screw driver



Final look of # fixed with two malleolar screws

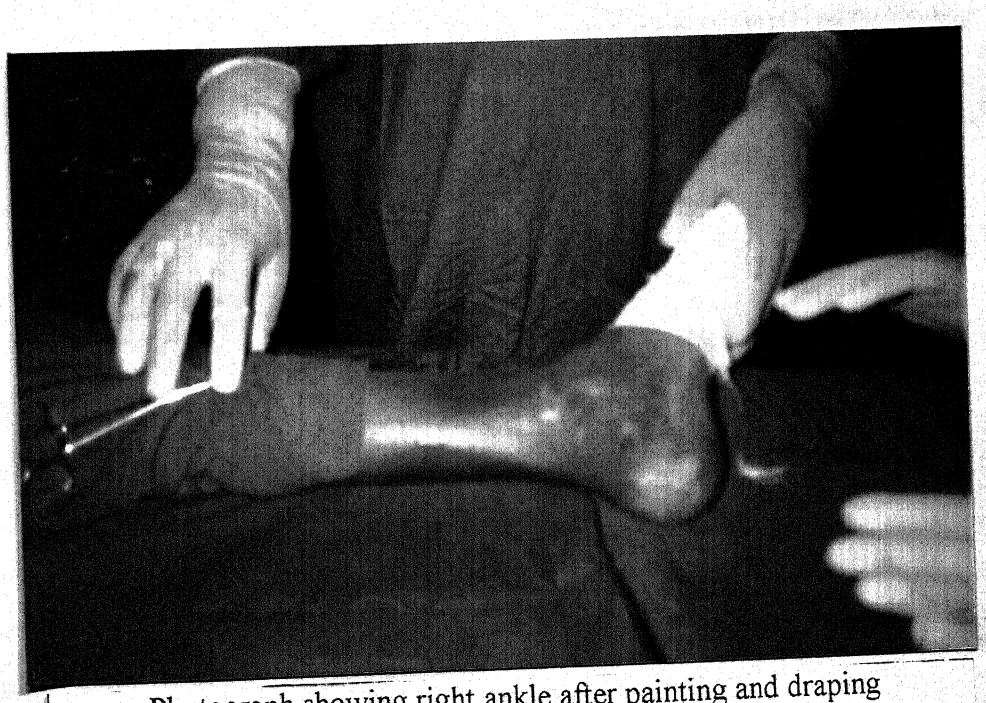


Plantarflexion of left ankle comparing with sound right ankle after six weeks post-op.

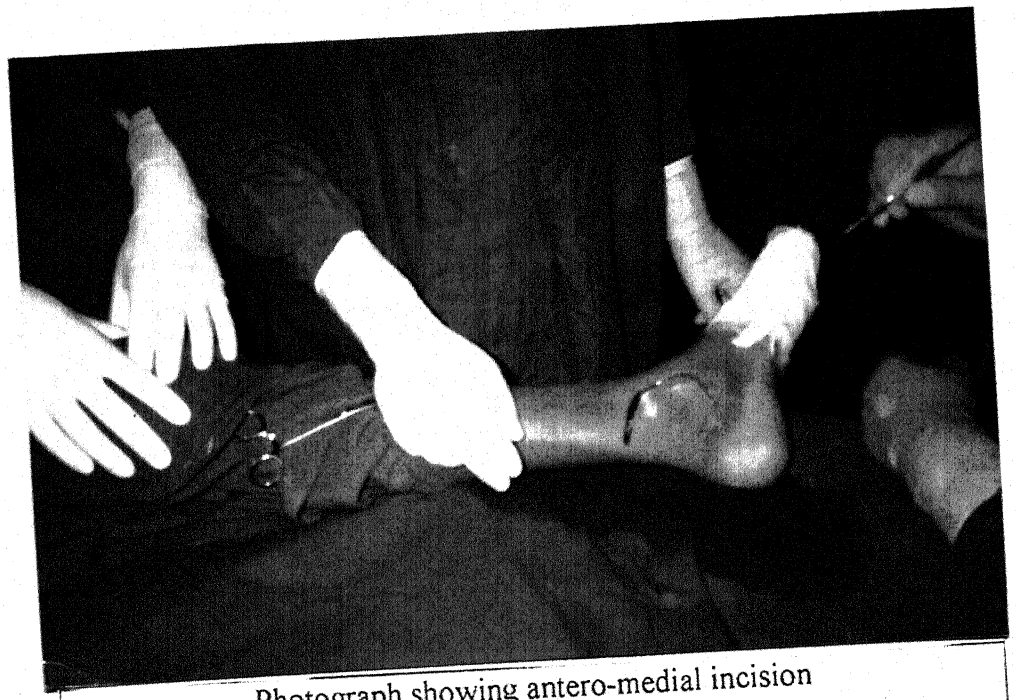


Dorsiflexion of left ankle comparing with sound right ankle after six weeks post-op.

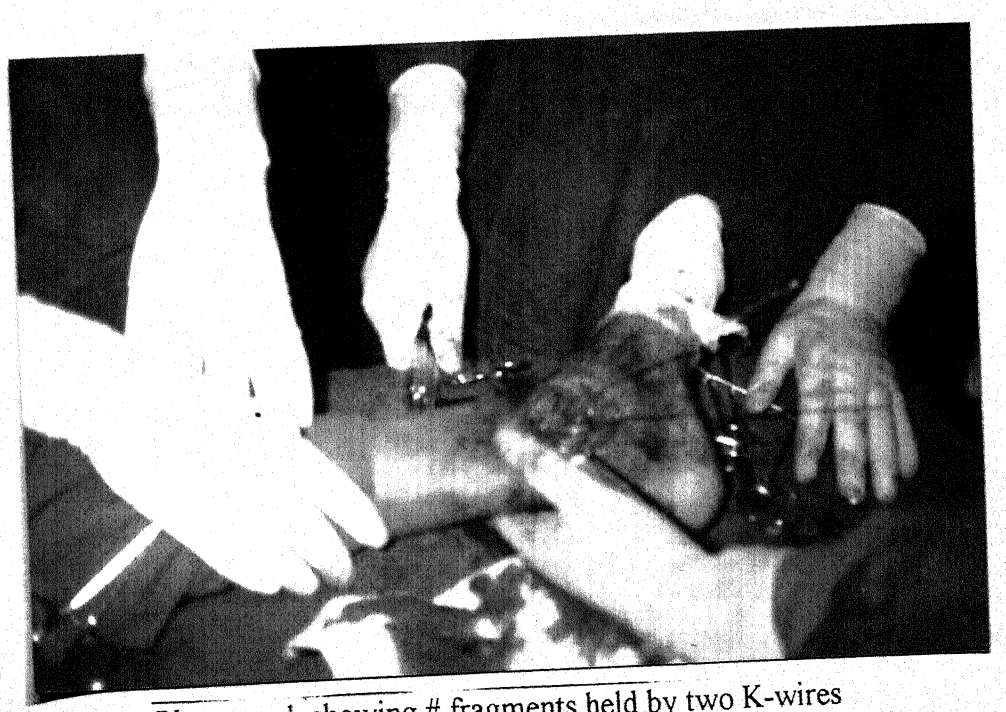
X-ray showing medial malleolus which was fixed with single malleolar screw



Photograph showing right ankle after painting and draping



Photograph showing antero-medial incision

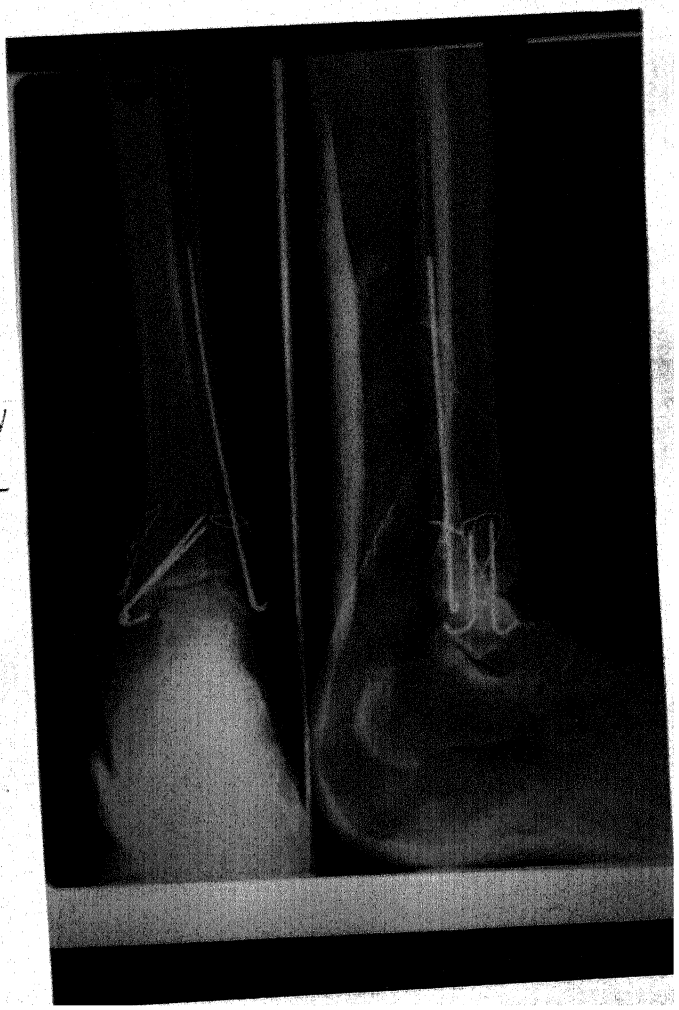


Photograph showing # fragments held by two K-wires

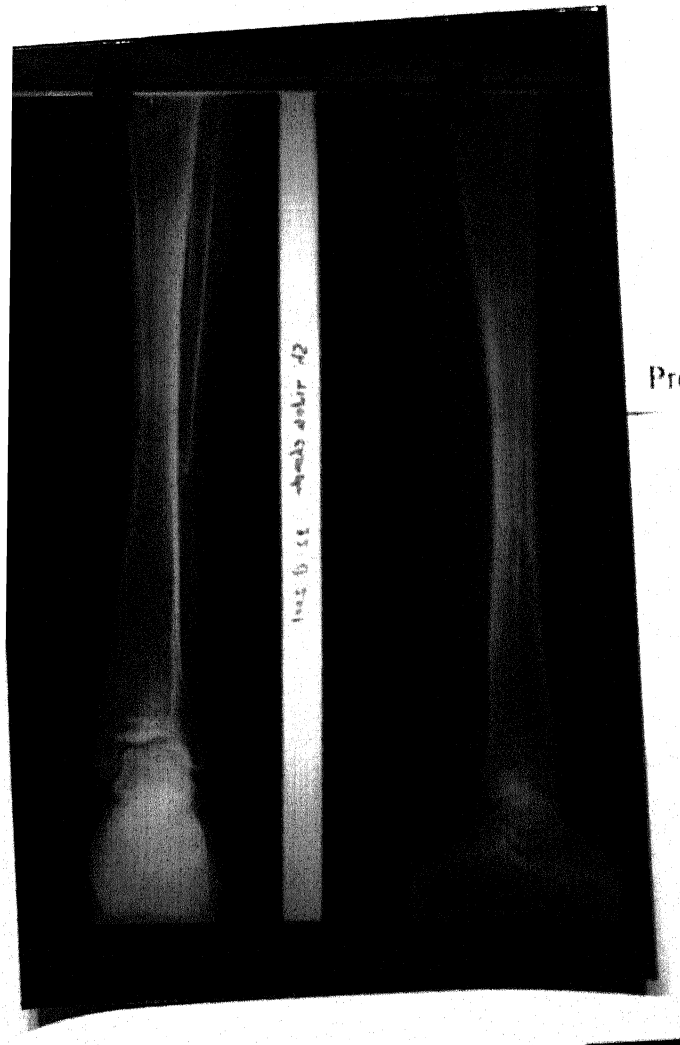
Photograph showing malleolar screw in # medial malleolus

Photograph showing right ankle after stitching

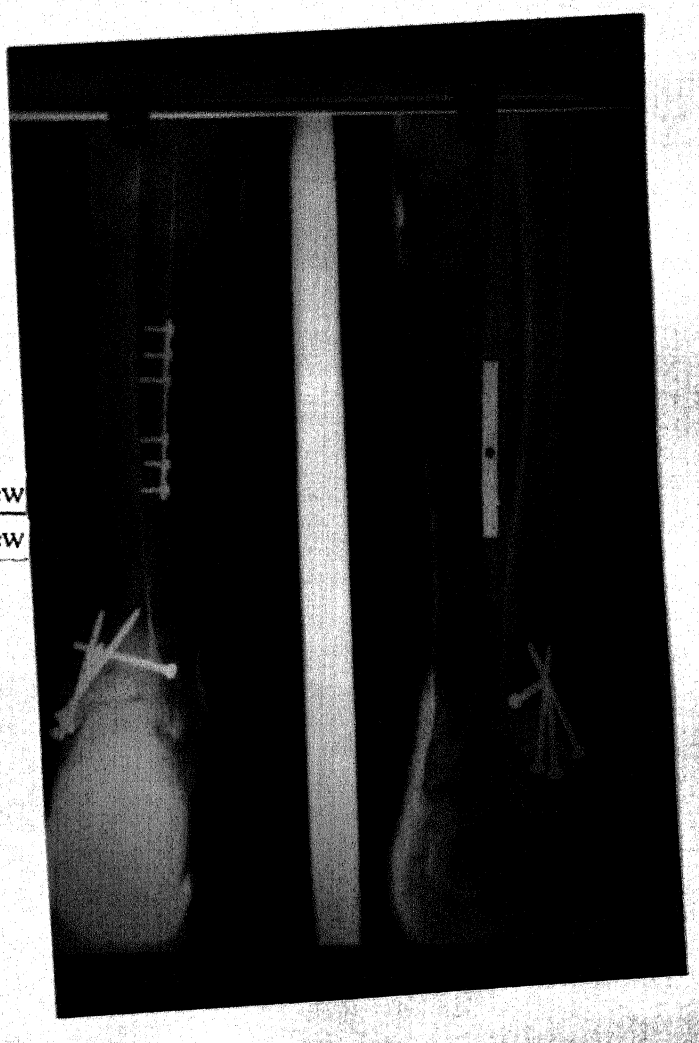
Pre-op X-ray showing # medial malleolus at joint level with comminuted # lateral malleolus



Post-op X-ray showing fixation with TBW & Rush pin with AO wire

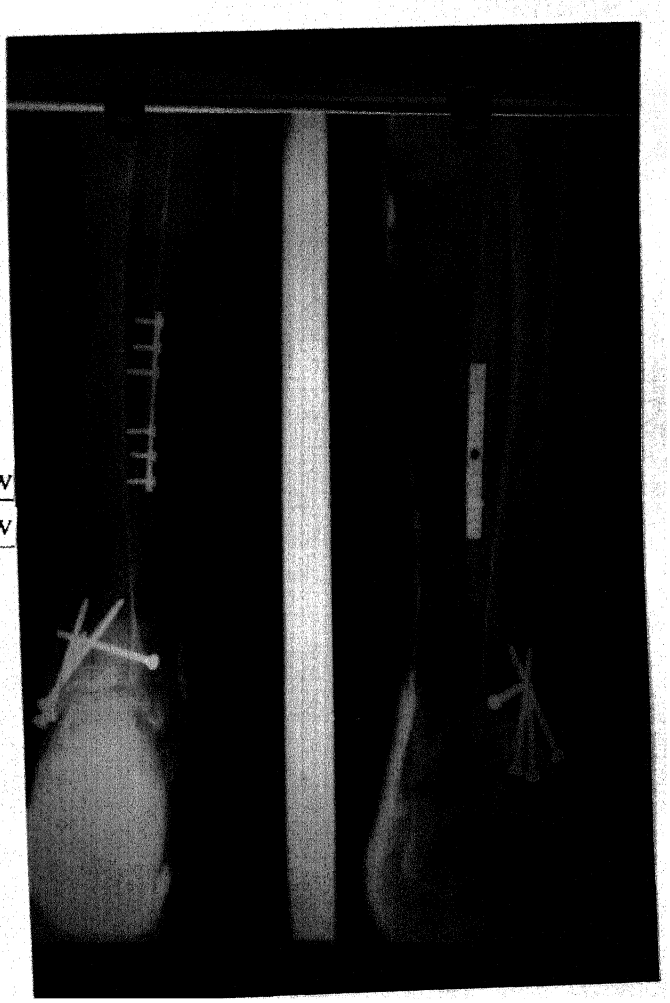


Pre-op X-ray showing transverse # medial malleolus with mid shaft # fibula



st-op X-ray showing # fixed with malleolar screw with semi tubular plate and syndesmotic screw

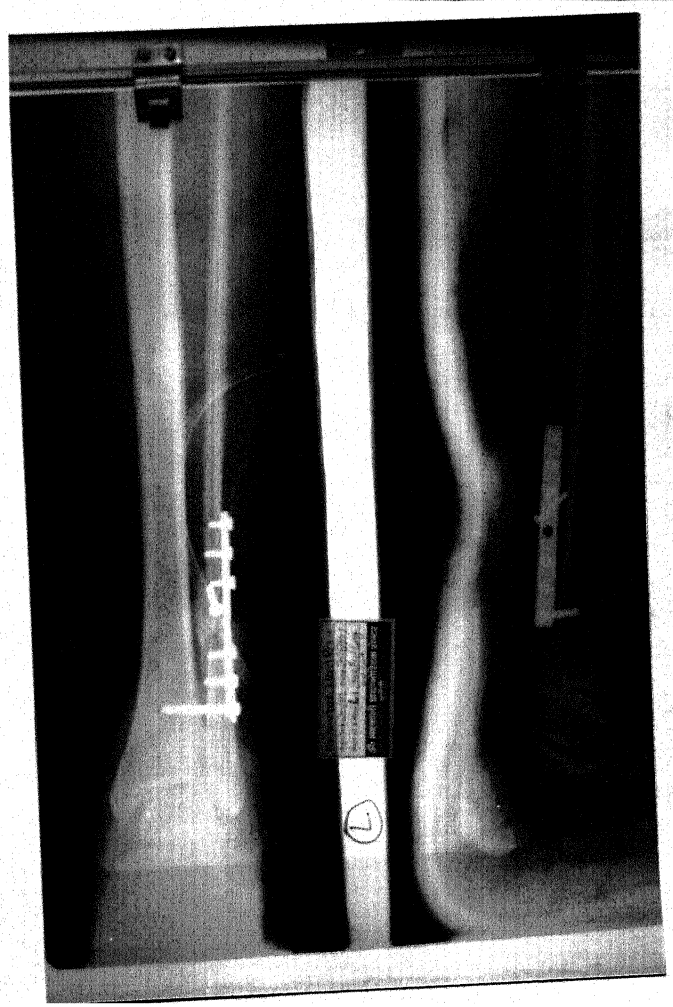
Pre-op X-ray showing transverse # medial malleolus with mid shaft # fibula



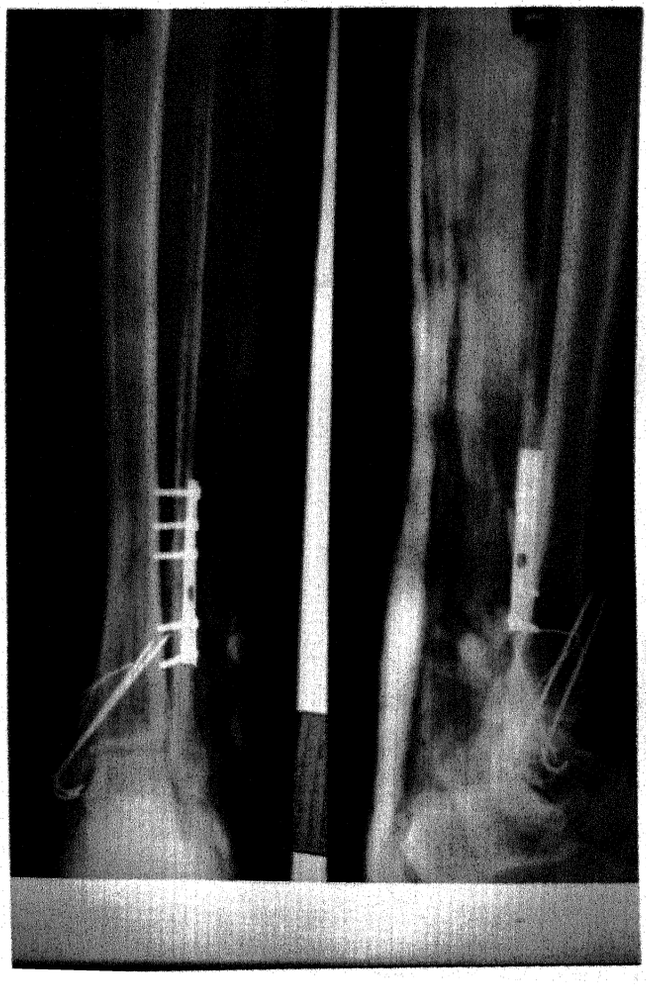
Post-op X-ray showing # fixed with malleolar screw with semi tubular plate and syndesmotic screw

Pre-op X-ray showing spiral # fibula with deltoid ligament injury

Post-op X-ray showing fibula fixed with semi tubular plate with syndesmotic screw



Pre-op X-ray showing tri malleolar #

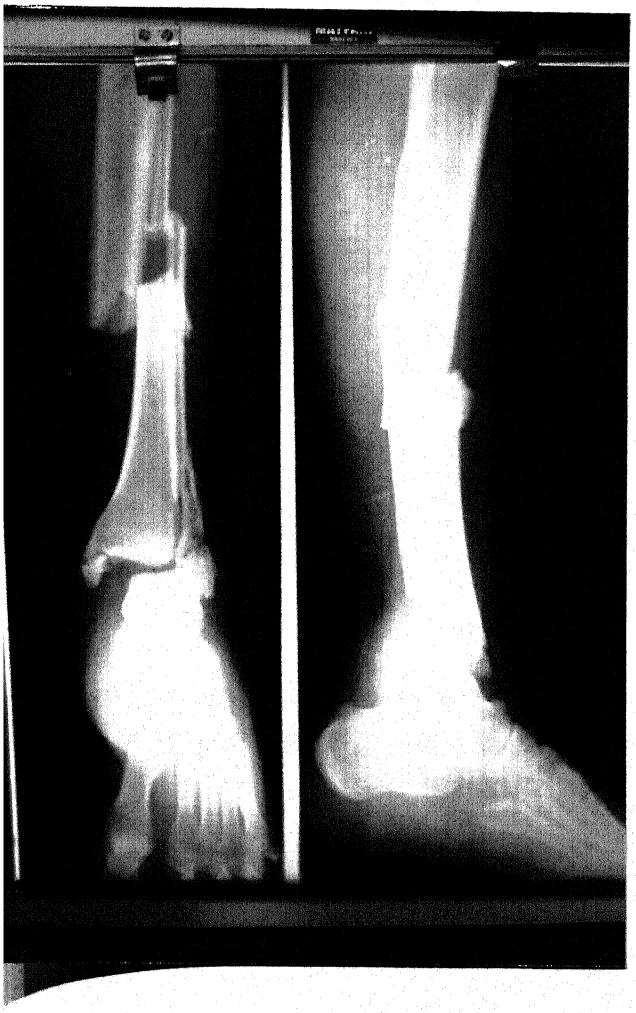


Post-op X-ray showing TBW with semi tubular plate

Pre-op X-ray showing transverse # medial malleolus with # mid shaft tibula

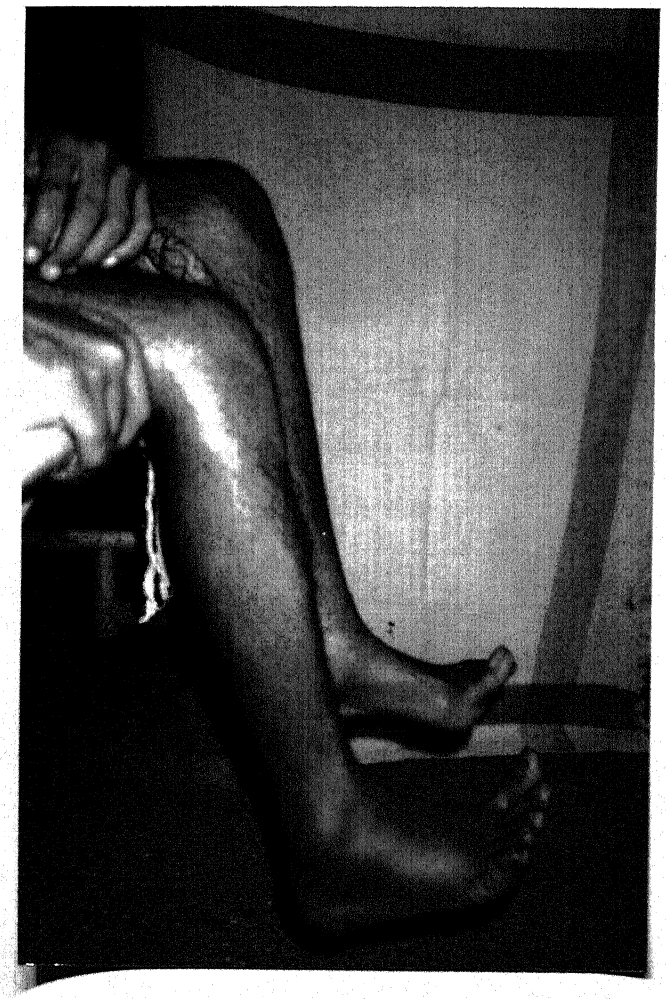
Post-op X-ray showing TBW with rush pin in fibula

COMPLICATIONS

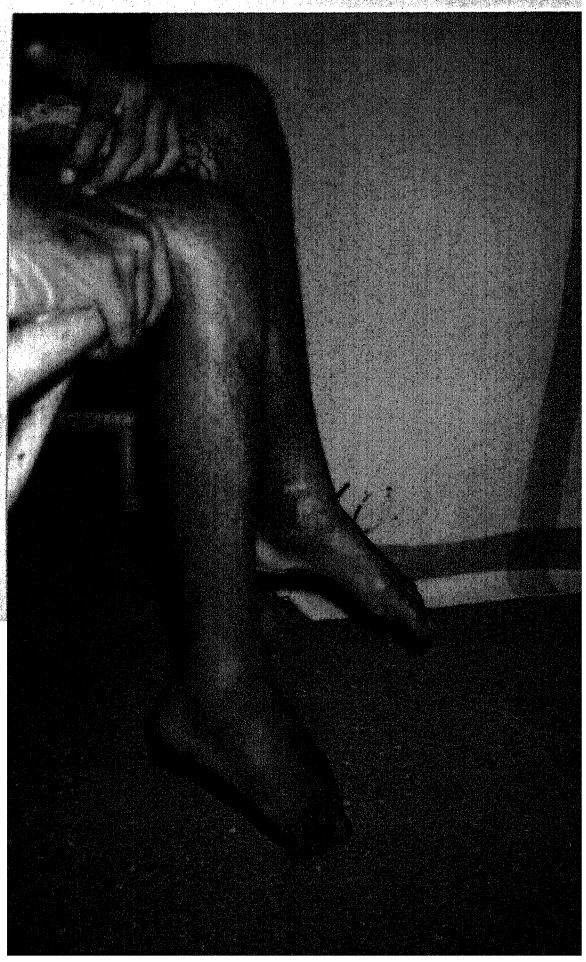


X-ray showing # B/B leg with transverse # medial malleolus with comminuted lateral malleolus treated conservatively

Patient right leg and ankle showing obvious deformity and swelling after six weeks



Patient showing decrease range of movements in dorsiflexion



Patient showing decrease range of movement in plantar flexion

X-ray showing broken medial malleolar screw after one year of injury when patient got re# of medial malleolus

Observations

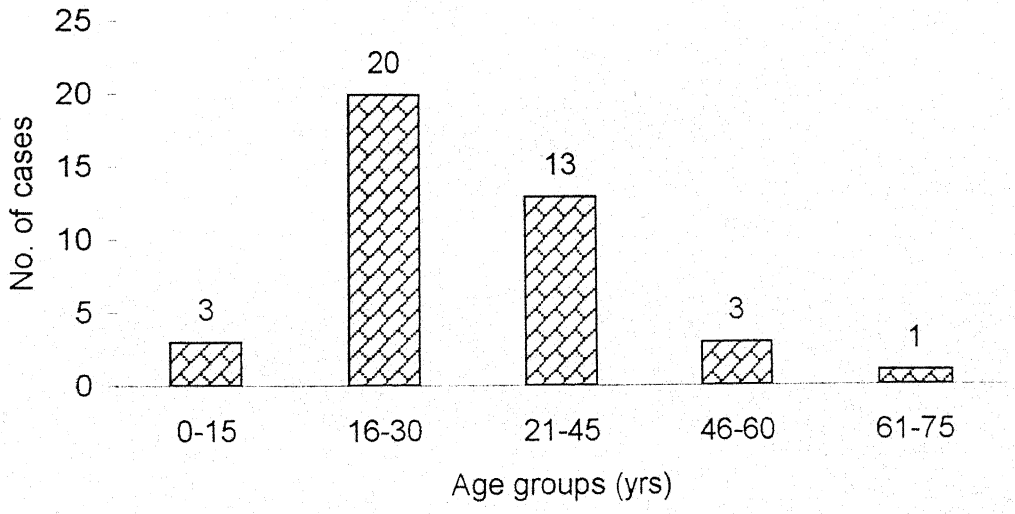
OBSERVATION

In the present series, the clinical analysis of 40 cases of injuries around ankle joint was performed in the Department of Orthopaedics, M.L.B. Medical College, Jhansi during May 2000 to July 2002.

1. Age incidence

In this series patients of all age groups have been studied. The youngest patient was 10 year old and the oldest was 65 years of age. The maximum number of cases were from young adults age group.

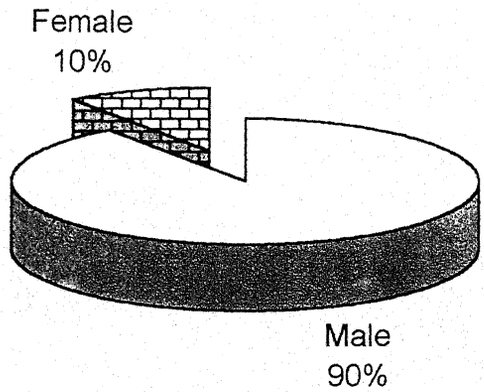
Fig-1 : Showing the incidence of ankle fracture at various age groups



2. **Sex :**

It was observed that ankle injuries are more common in males. Out of 40 cases, 36 were males and four were females.

Fig-2 : Showing the ratio of male to female scrumbling to ankle fracture

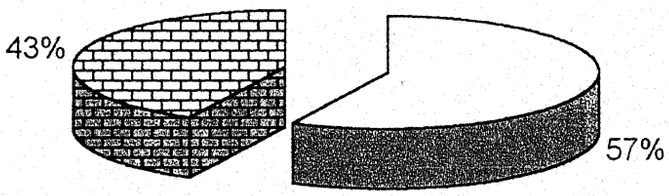


3. **Side of injury :** In this series left side had been affected more as compared to right side.

Table- 1 : Showing sideness of injury in ankle fractures.

Side affected	No. of cases	Percentage
Left	23	57.5
Right	17	42.5
Bilateral	Nil	-

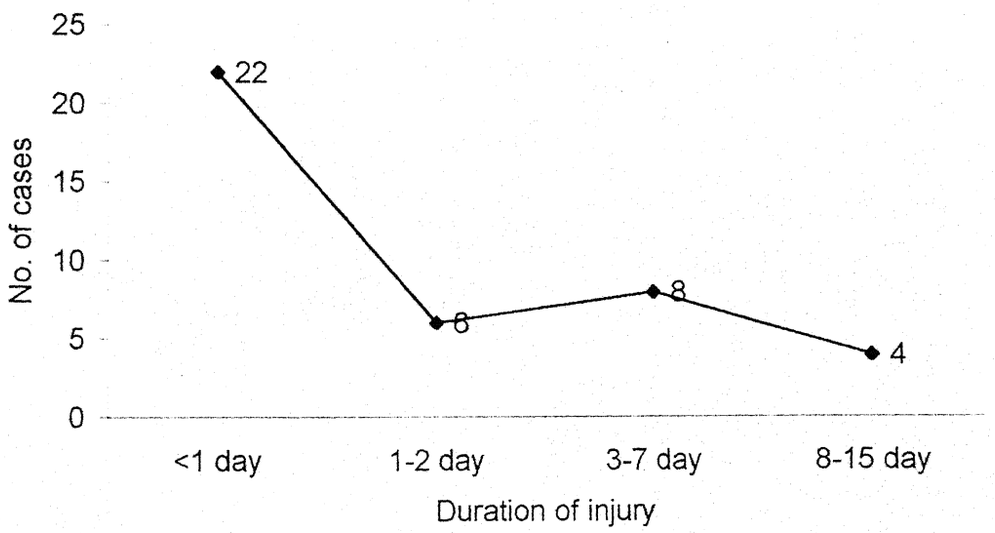
Fig- : Showing sideness of injury in ankle fractures



4. Time interval between injury and treatment given :

The maximum number of patients reported within 24 hrs of injury to casualty department of our hospital. Earliest patient reported two hrs and latest after 15 days of injury.

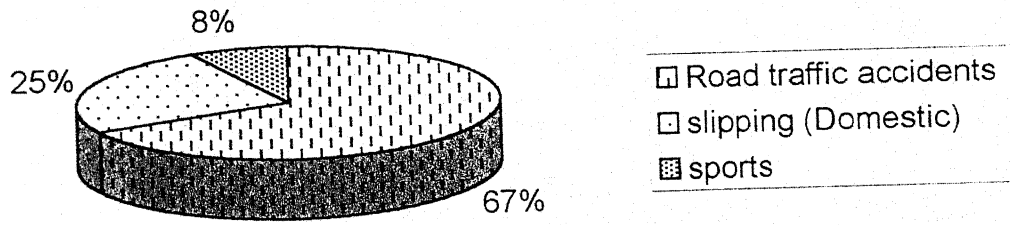
Fig-3 : Showing time interval between injury and treatment given in ankle fracture



5. Mode of injury :

In our series maximum number of injuries were from road traffic accidents.

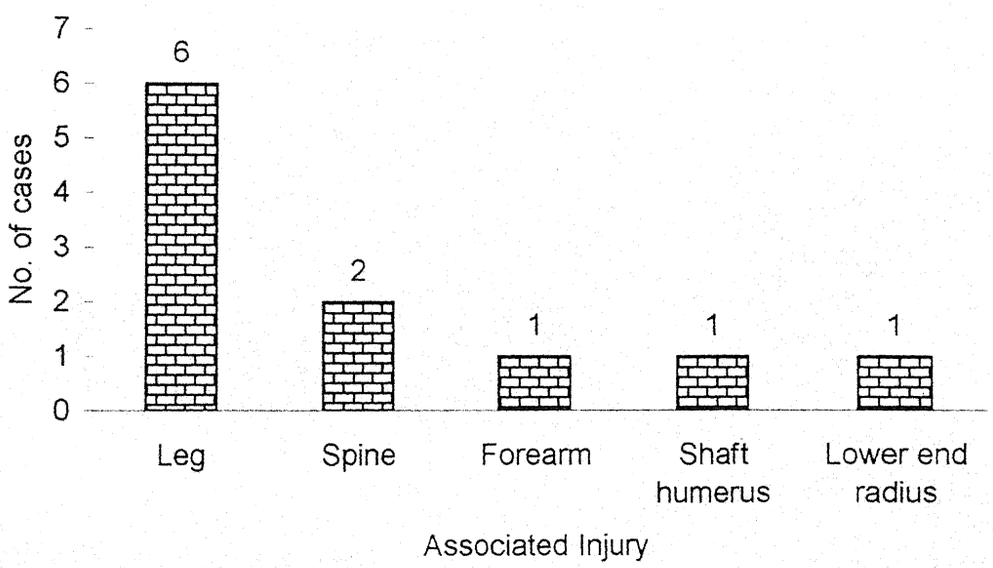
Fig-4 : Showing the mode of injury in this study



6. Associated injuries :

Out of 40 patients 10 patients had associated injuries. One patient had bilateral fracture both bone leg.

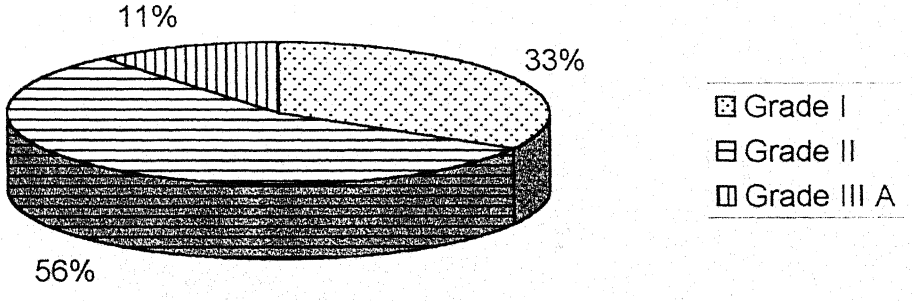
Fig-5 : Showing incidence of associated injuries in ankle fractures



7. Incidence of compound fracture :

Out of 40 patients nine had compound fractures.

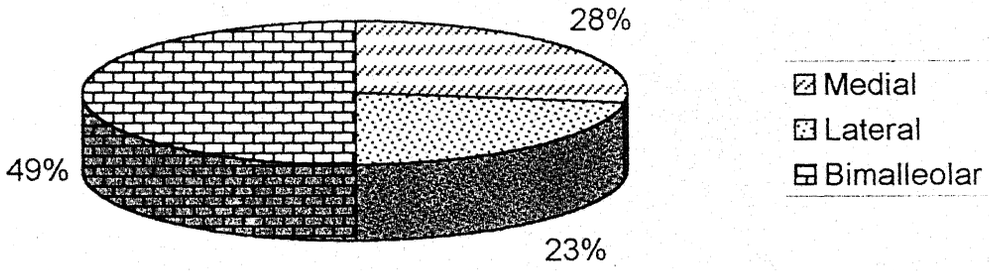
Fig-6 : Showing incidence of compound fractures in ankle fractures



8. Bony injuries :

Out of total cases, 20 cases had bimalleolar fracture, 11 cases had only medial malleolus fracture and nine cases had lateral malleolus.

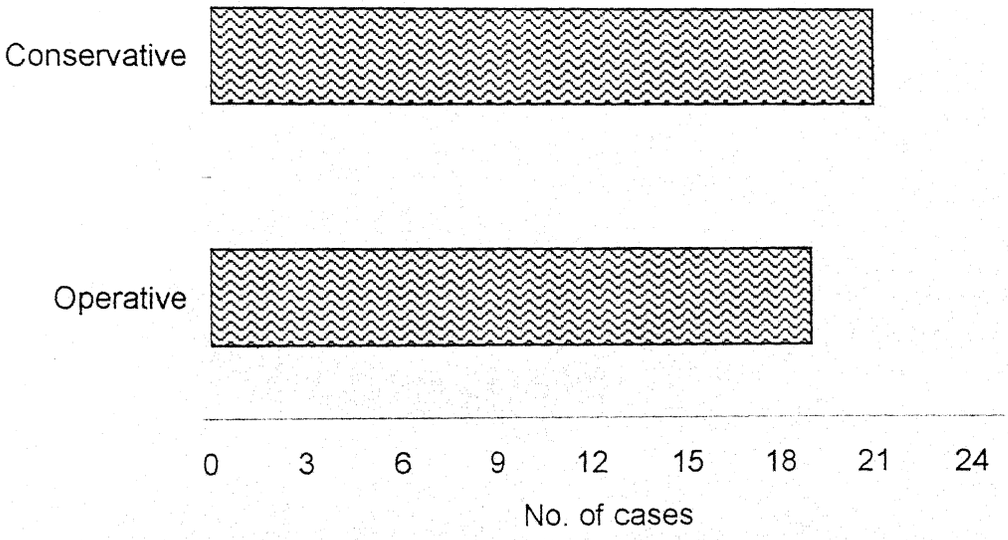
Fig-7 : Showing incidence of type of fracture in this study



9. Treatment of fractures :

Out of 40 patient 19 were treated operatively and 21 patients treated conservatively.

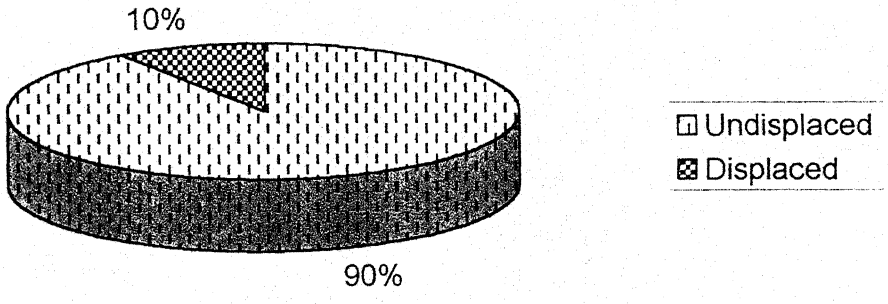
Fig-8 : Showing the type of treatment given in this study



10. Conservative treatment :

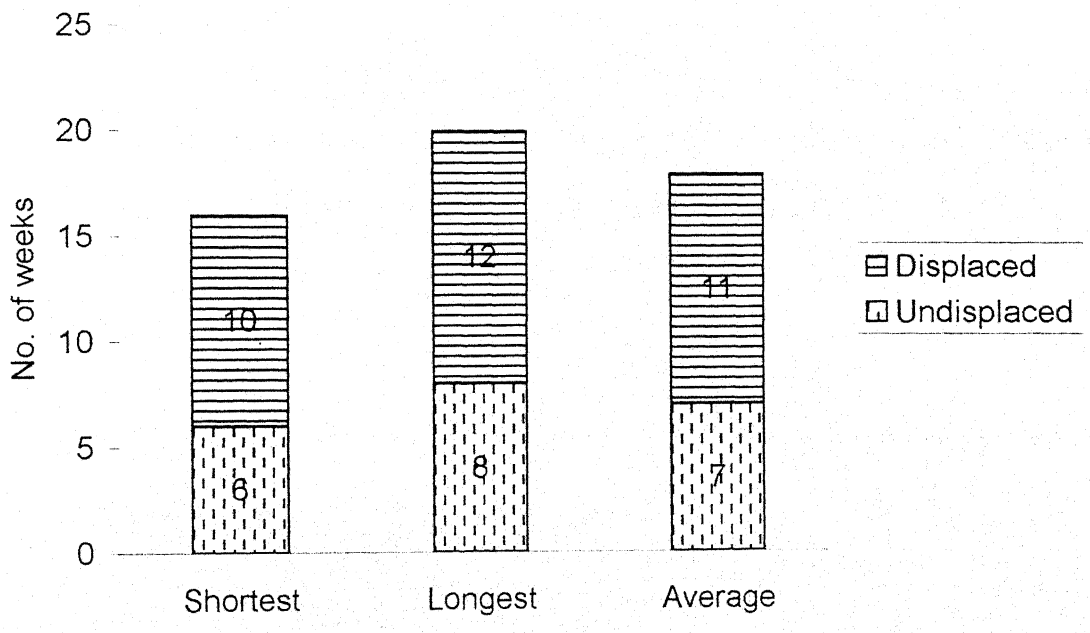
Out of 21 patients treated conservatively 19 were undisplaced and two displaced fractures.

Fig-9 : Showing incidence of type of fracture in conservative treatment



11. Period of immobilization in weeks in fractures treated conservatively.

Fig-10 : Showing the period for which immobilisation was done in conservative patients



12. Operative technique :

(i) ***Medial malleolus*** : In our series eight cases were fixed by malleolar screws, six cases by tension band wiring and four cases by k-wires.

Table –2 Showing type of treatment given for fracture medial malleolus

Fracture medical malleolus		*No. of cases*
i)	Malleolar screw	8
ii)	Tension band wiring	6
iii)	K-wires fixation	4

(ii) ***Lateral malleolus*** : In our series four cases were treated with semitubular plate, six cases were treated with Rush spin and four cases treated with K-wires fixation.

Table –3 Showing type of treatment given for fracture lateral malleolus

Fracture lateral malleolus		*No. of cases*
i)	Semitubular plate	4
ii)	Rush pin	6
iii)	K-wires fixation	4

(iii) ***Syndesmosis*** was fixed in three cases by syndesmotic screws.

13. Time of operation :

15 cases out of 19 were operated within seven days injury, three cases were operated within 7-14 days and one case was operated with in 15-30 days.

Table –4 Showing the time of operation in this study

Days	No. of cases	Percentage
0-7	15	78.94
7-14	3	15.78
15-30	1	5.26

14. *Post operative immobilization :*

Below knee plaster cast immobilization was done in all the cases for a period of six weeks to 10 weeks depending upon type of fracture and associated fractures.

In 12 cases of unimalleolar or bimalleolar fracture it was immobilized for six weeks, in four cases for eight weeks who had compound fractures. In three cases it was for 10-16 weeks who had associated fractures both bone leg.

15. ***Follow-up results :***

Out of 40 patients 19 were treated operatively of which one case was lost to follow up. 21 cases were treated conservatively.

Table-5 Showing follow-up results

Type of injury and treatment	No. of cases followed up
Conservative	
Undisplaced	19
Displaced	2
Operative	18
Total	39

16. Final results :

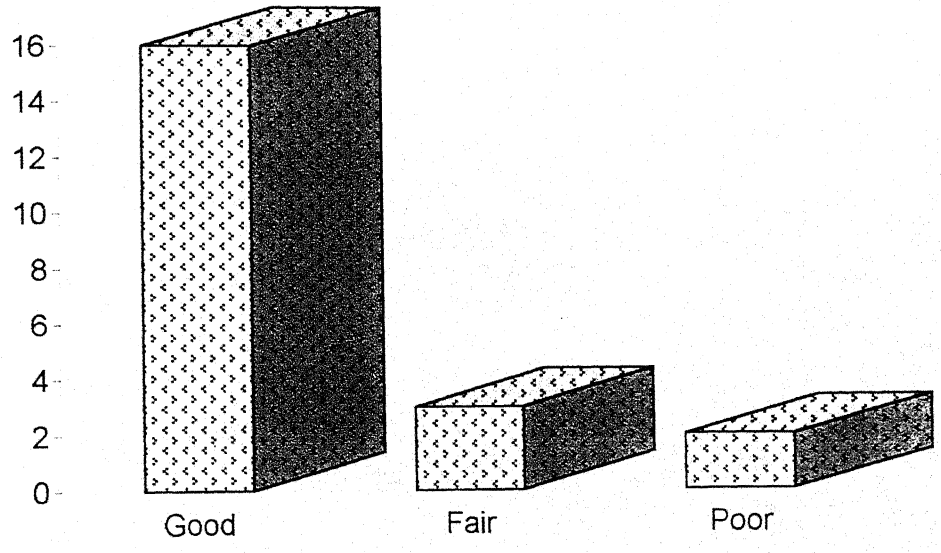
(i) Bony injury treated conservatively.

Good results - 76.19%

Fair results - 19.28%

Poor results - 9.5%

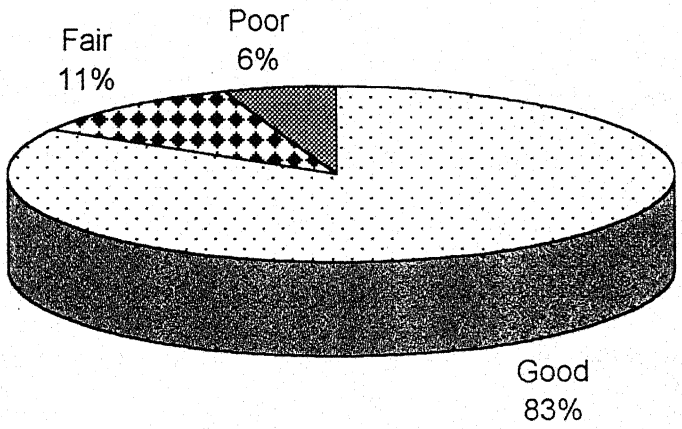
Fig-11 : Showing results of cases treated conservatively



(ii) ***Bony injuries treated by operative methods***

Out of 19 cases, 18 cases were followed up.

Fig-12 : Showing results of cases treated by operative methods



17. Complications :

(i) ***Swelling*** : Persistant and recurrent edema around ankle specially after use during the day found in 15 cases.

Table –6 Showing incidence of swelling after various treatment given

Type of treatment	No. of cases
Undisplaced fracture treated conservatively	4
Displaced fractures treated operatively	11

(ii) ***Stiffness*** : In 12 cases, there was restriction of movements. Out of these cases, five cases had restriction of movement less than half of the normal range. These included three cases treated by conservative means and two cases treated by operative means.

Table-7 Showing cases of stiffness

Degree of stiffness	No. of cases	
	Conservative	Operative
> 50% limitation	5	2
<50% limitation	3	2

(iii) ***Non-union*** : Seen in one case who was treated conservatively.

(iv) ***Malunion*** : Out of 40 patients treated, two cases develop malunion and deformity out of which one case was treated operatively and one case was treated conservatively.

(v) ***Infection*** : Deep infection occurred in one case of injury. In four cases there was superficial stitch infection which improved with change of antibiotics and regular cleaning and dressing of wound.

* * * * * *

Discussion

DISCUSSION

The treatment of fractures of the ankle have received great attention and elicited diverging opinions. These injuries have been a matter of serious concern to the orthopaedic surgeons, as the ankle joint has to bear the maximum static body weight. Ankle injuries are indeed very common.

This means that ankle injuries constitute a quantitative therapeutic problem that must be solved in the best way considering the available economic and medical resources, however the demand for high quality in the treatment must not be omitted.

In the present study; by using various parameters to cover different aspects of ankle fractures, analysis has been made to analyze and understand the problem associated with these common yet complicated injuries.

AGE AND SEX INCIDENCE

Harvey (1965); Segal (1975); Cedell (1975); noticed ankle injuries are more common in young adults. Similar observation has been made in this study also. Maximum incidence was found in adults between the age of 16-45 years (Fig no.1). This is because they lead more vigorous outdoor life and hence more exposed to injury. Burwell and Charnley (1965), reported maximum incidence between 60-69 years of age. In this series however, is sharp decline in incidence of injury

after the age of 60 years. The oldest patient in this study was 65 years. The disparity in the age incidence is due to lower average life span in our country as compared to the west and also because people in our part are less active in their old age than their western counterparts.

This sex incidence showed that the ratio of male and female was 9:1 as there were 36 males four females in the present series. Sex ratio observed by authors is as follows :

Lange Hansen (1952)	1.6:1
Vasli (1957)	1:1.4
Klossnee (1962)	2:3
Meyer & Kumbler (1980)	1:1.25

Burwell and Charnley (1965) also noted higher incidence of ankle injuries among males. This is because the male leads an active life and females are generally confined to home. While in western countries, this is not so. Sex incidence was equal in the series of Brostom (1965).

SIDE OF INJURY

In the present series 23 cases had left side involvement and 17 cases had right side involvement.

Brostrom (1965), reported more involvement of right side and C.L. Colton (1971) reported more involvement of left side.

DELAY IN REPORTING TO THE HOSPITAL

Only 55% cases reported within 24 hours but within 48 hours after injury, rest cases reported after that including 10% (four cases) who reported after 15 days.

The delay in coming to the hospital, was due to either the ignorance, lack of transport facilities or to the indigenous treatment suggested by quacks, as was observed after asking leading questions with the patients.

TREATMENT RECEIVED BEFORE REPORTING TO HOSPITAL

Only 10 patients who had reported after 24 hours had received proper first aid before reporting to this hospital. While three cases had manipulation and massage done by the quacks. These observations highlight the gross need of proper orthopaedic care at peripheral level which is so obviously, lacking in our country.

MODE OF INJURY

Commonest mode of injury was road traffic accidents (67%) followed by domestic accidents (25%) and rest by sports injury (8%).

Maximum number of cases reported by Burwell and Charnley (1965) were due to slipping or stumbling (46%) followed by road traffic accidents (15%) and fall from stool or steps (15%). Thus, as contradictory in present series we rather had maximum number of injuries by road traffic accidents because of over crowded roads, low standard of living, poor

maintenance of vehicles, bad conditions of roads and mixed traffic.

ASSOCIATED INJURIES

Out of 40 patients 10 patients (25%) had associated injuries while Burwell and Charnley (1965) reported this only in four of their 135 cases. Higher incidence of associated trauma in this series is due to high velocity road traffic accidents.

COMPOUND INJURIES

In this series nine patients (22.5%) out of 40 cases, had compound ankle fractures. Klowner (1962) observed (27%) and Burwell and Charnley reported (52%) incidence of compound ankle fractures.

In present series 33% of all the compound injuries had grade I compounding, 56% had grade II compounding and 11% had grade IIIA compounding. Chapman and Mohanty (1976) found 60% of grade I compounding and 10% had grade III compounding.

Compound fractures in ankle are common because the bones around the ankle are subcutaneous.

CLASSIFICATION ACCORDING TO THE NUMBER OF MALLEOLI FRACTURED

In the present series 50% had unimalleolar fractures and 50% had bimalleolar fractures. Burwell and Charnley (1965)

reported 18% of unimalleolar, 49% of bimalleolar and 32% of trimalleolar fractures.

The difference is due to the fact that in the present series the majority of cases had injuries in stage I or II only.

TREATMENT OF FRACTURES

Out of 40 cases, 19 cases (47.5%) were treated by operative means and 21 cases (52.5%) were treated by conservative means. Burwell and Charnley (1965) operated 15.8% cases and managed 84.2% cases by conservative means. Brodie and Denham treated 15% of their cases by operation and 85% cases by conservative means. Danis and Jansen (1971) emphasized the operative treatment, as only this can make anatomically satisfactory reconstruction of a malleolar fracture.

(A) CONSERVATIVE TREATMENT

Conservative treatment was undertaken in all the 19 cases of undisplaced fractures and two cases of displaced fractures. In the present series a below knee plaster immobilization was given in all 19 cases of undisplaced fractures. In displaced fracture above knee cast applied after closed reduction, in these immobilization was done for 6-12 weeks.

Yablon and Wasilewski (1981) advised repeat check X-ray to see any displacement. as sometimes, the fracture may displace in the cast.

(B) OPERATIVE TREATMENT

In 19 cases of displaced fractures, operative treatment was done. The operation was done in potentially unstable injuries as in cases where medial malleolar fragment was at joint level or there is diastasis of inferior tibiofibular joint or in cases where closed reduction fails. AO group surgeons (1966) aim at a totally stable joint reconstruction.

OPERATIVE PROCEDURES

Medial malleolar fractures were exposed through a longitudinal incision. Chapman (1992) also exposed through a straight incision midway between its anterior and posterior borders of tibia. Similar approach was suggested by Brodie and Denham (1974), Segal (1979).

In the present series most of the medial malleolar fractures were fixed by two cancellous screws. Burwell and Charnley (1965) fixed medial malleolus by one screw in 76.4% cases, by two screws in 11.38% cases and pins in 7.3% cases. so, the commonest method for fixation of medial malleolus is screw fixation but small fragments can either be fixed by tension band wiring or k-wires.

Lateral malleolus or lower $1/4^{th}$ of fibula were approached by a laterally placed longitudinal incision. In the present series most of the fractures of lateral malleolus were fixed by Rush pin. Five cases with fibular fractures were not fixed. AO

surgeons described the internal fixation of fibula according to configuration of fracture.

Burwell and Charnley (1965) used plate and screws in 23% cases and screws in 51.7% cases and in 20.6% no fixation was done.

Syndesmosis was fixed by a horizontally placed cortical screw. Burwell and Charnley hold the opinion that trans syndesmotic fixation is not essential when the associated fracture have been fixed. Bonnin (1950), Mayer (1956), Vasli (1957), Colton (1968), AO surgeons and Chissell & Jones (1995), suggested syndesmotic fixation if it is unstable.

TIME OF OPERATION

15 cases (78.94%) were operated within seven days of injury, three cases (15.78%) were operated after 7-14 days of injury and one cases after 15 days of injury. Burwell and Charnley (1965) operated majority of cases on the same day. Klossner (1979) also suggested that surgery should be done within few hours.

In the present series delay was in majority of cases, due to late reporting to the hospital and in others due to some ailment during pre-anaesthetic period.

POST OPERATIVE IMMOBILIZATION

Below knee plaster cast immobilization was done in all the cases for varying periods depending upon type of fracture and associated fractures.

When rigid internal fixation was done then post operative immobilization was done for about 6-10 weeks. This was followed by non weight bearing active physiotherapy of ankle and foot joints. Similar regime was advocated by Mast and Trigher (1980), Mayer and Kumbler (1980).

Burwell and Charnley also advocated more then eight weeks immobilization in cases where limited internal fixation was done. Muller et al (1969) advised non-weight-bearing crutches after internal fixation and active range of movements.

PERIOD OF FOLLOW-UP

Thirty nine patients were followed for a period of six weeks to 12 weeks after the treatment given. In Bruwell and Charnley (1965) series cases were followed up for a average of 34 months. In Meyer and Kumbler's study average follow up period was 38 months. Because the period of follow up in this series is shorter for the late complications to develop like arthritis, so few good results may deteriorate with time.

END RESULTS

End results in all the cases that could be followed up were assessed and graded according to criteria suggested by Klossner (1962), Olerud and Molander (1984).

(A) END RESULTS IN CONSERVATIVELY TREATED PATIENTS

Out of 21 cases that were followed up, 16 cases (76.19%) had good results, three cases (14.28%) had fair results and two cases (9.52%) had poor results. In three cases who had fair

results, there was restriction of movement especially dorsiflexion, swelling and pain while walking. In all three cases immobilization was for longer period as they had associated fracture both bone leg. One patient developed non-union of medial malleolus with limping and another patent had both limping and deformity of leg with swelling and restriction of movements. They both were kept in poor results.

Burwell and Charnley (1965) stated that joint stiffness is common problem after closed method of treatment and chances of stiffness are more with longer period of immobilization and poor quality of reduction.

(B) END RESULTS IN FRACTURES TREATED BY OPERATIVE METHODS

Out of 18 patients that were followed up 15 patients (83.33%) had good results, 2 patients (11.11%) had fair results and one patient (5.5%) had poor result.

Patients who had fair results where having compound fractures and both were fixed by K-wires. Out of two cases, one case had deep wound infection for which later on K-wires were removed. Both had restriction of movements and moderate amount of swelling as they were immobilized for longer periods.

One case had poor result who had compound fracture grade IIIA for which K-wire fixation done. Fracture reduction

was lost and patient developed swelling, limp and obvious deformity.

Comparing results of operative and conservative treatment

	Results		
	Good	Fair	Poor
Conservative	76.19%	14.28%	9.52%
Operative	83.33%	11.11%	5.55%

Better results were obtained following operative treatment in the present series. Operative treatment was done in most of unstable and compound ankle injuries. This is in accordance with the findings of most authors like Danis (1949), Hobmann (1950), Vasli (1957), Willeneggar and Weber (1963), Denham (1964), Burwell and Charnley (1965).

Rowley, Norris and Duckworth (1986) reported that if a good reduction can be achieved and maintained then closed treatment is as good as operative treatment.

COMPLICATIONS

Swelling :

Persistent or recurrent oedema around the ankle, specially after use during the day was found in 15 cases. This problem was observed in 37.5% of cases in both groups whether they are treated by conservative methods or operative methods. This is not in accordance with the observation of Burwell and

Charnley (1965), CL Colton (1971). They have observed this complication more in conservatively treated patients. In most of the cases this was overcome by application of elastic crepe bandage, elevation of the limb during the night and active physiotherapy.

Stiffness :

Joint stiffness was found in cases where initial displacement was more, cases that were immobilized for longer time and in compound fractures. Dorsiflexion was limited more than plantar flexion in majority of cases. More than 50% limitation of movement was observed in 17.9% cases in both groups whether they are treated by operative or conservative method. Brannstein and Wade (1955), Watson Jones (1959), Burwell and Charnley (1965) reported that it is more common in conservatively treated patients because of improper reduction and immobilization for longer period.

Non-union :

Non union medial malleolus was seen in one case (2.5%) who was treated conservatively. This patient was not ready for operation initially at the time of injury as the fracture line was transverse and displaced. Similar incidence was observed by various authors in conservatively treated patients. Non union occurs either because of interposition of periosteum, infection or improper reduction.

Joes and Neal (1962)	-	7%
Klossner (1962)	-	10%
Sneppen (1969)	-	9.1%

Malunion :

Out of 39 cases who had ankle fractures two cases (5.1%) developed malunion. One case was treated conservatively and one case was treated operatively.

Cedell and Wiberg (1962), Wilson and Skilbred (1966) also noted the external rotational deformity of lateral malleolus.

Infection :

Deep infection occurred in one case (2.5%) which was compound grade III A fracture fixed by K-wires. The reported incidence varies from 1% to 18% in closed fracture treated surgically. In four cases (10.25%) there was superficial infection which improved with change of antibiotics and regular cleaning and dressing. The incidence of infection is high because the most cases were treated in emergency O.T. with limited resources, and patients having unhealthy skin.

* * * * * *

Conclusion

CONCLUSION

Ankle injuries are very common, they occur most commonly because of road traffic accidents, slipping and twisting and in sports. Ankle fractures have been one of the difficult problem to tackle.

Much had been heard about the mechanism of injury to the ankle on the basis of clinical examination, post mortem dissection, and the laboratory production of examination injuries in cadevers by various workers, even before the invention of roentgenography.

Lauge-Hansen described injury mechanism in 1950 and classified ankle injuries according to mechanism of injury. After him Jergesen (1959) and Danis-Weber (1966) also classified the ankle injuries. In the present series the injuries are classified according to Lauge-Hansen's classification.

Clinical examination is very important and is very much helpful in diagnosing the ankle injuries. Sometimes special views are required to confirm the diagnosis.

Most of the cases of undisplaced fractures can be successfully treated by conservative means as was present in this series. The displaced fractures should be treated by operative methods as proper and rigid fixation is required to achieves good result.

In the present series a clinical and radiological study of 40 cases of ankle injuries was done using a wide range of parameters to find out different aspect of ankle injuries regarding their mechanism, classification, diagnosis and problems of management. From the observations made during the study following conclusions are drawn :-

1. Ankle injuries occur more commonly during active working period of adult life. Males are affected more because they lead more vigorous out door life.
2. Road traffic accidents, domestic accidents like slipping or stumbling and sport injuries are common mode of injury.
3. The information regarding the mechanism of injury in most of the cases could be obtained from radiographs as patients can not recollect the direction of injuring force.
4. Many cases of ankle fractures have other associated injuries following road-side accidents.
5. Ankle fracture are more common on left side in present series.
6. Apart from conventional antero-posterior and lateral views, mortise views is also very useful for the diagnosis of diastasis.
7. Undisplaced ankle fractures were satisfactorily treated by conservative methods with upto 80% good results.

8. In displaced fractures quality of end result depends mostly on the accuracy of reduction which can be, more often, achieved by operative methods.

9. Fractures and epiphyseal separations around the ankle in children are easily reduced by closed reduction and maintained by plaster cast.

10. Incidence of complications like swelling and stiffness are common in fractures treated operatively and conservatively respectively. In the present series more cases of fractures have been treated by conservative means.

It was concluded in the present series that there is not very much difference in results of ankle fracture whether treated operatively or conservatively. But it is for sure that proper reduction and rigid internal fixation can be achieved only by operative treatment for displaced fractures.

* * * * * *

Appendix

APPENDIX - I

S. no.	Name	Age	Sex	Side	Mode of injury	Diagnosis	Time between injury & treatment	Associated injury if any	Closed v/s open fractures	Treatment done	2 wk	6 wk	12 wk	Final results	Complications	Remarks
1	RL	35	M	R	A	M. Mal.	15 days	L/W dorsum foot	C	Two M. Mall screws	S++ DF15 PF35	S+ DF20 PF40	S+ DF20 PF40	Good		Skin grafting done on foot
2	MI	40	M	R	Sl.	Bi. Mal.	6 days	-	C	TBW plate	S++ DF15 PF30					Absconded
3	RV	25	M	L	A	L. Mal	2 hrs	-	C	Con		S++ DF20 PF45	S+ DF20 PF45	Good		
4	RM	24	M	L	Sl.	M. Mal	6 hrs	-	O	TBW	S++ DF15 PF35	S++ DF20 PF41	S+ DF20 PF40	Good		
5	RI	60	F	L	Sp.	B. Mal	6 hrs	-	O	K-wire	S+++ DF10 PF25	S++ DF10 PF25	S+++ DF10 PF25	Poor	Deformity + Limp +	K-wire removed at 8 wks
6	MN	22	M	R	Sl	M. Mal	12 hrs	-	C	Con		S++ DF20 PF40	S+ DF25 PF45	Good		
7	RK	25	M	L	A	Bi. Mal	2 day	-	C	Mall screw plate	S++ DF25 PF40	S+ DF25 PF40	S+ DF25 PF40	Good		
8	HR	20	M	L	A	L. Mal	8 day	# B/B forearm lt.	C	Plate + syndesmosis	S++ DF20 PF35	S+ DF20 PF40	S+ DF20 PF45	Good		Screw removed on 8wks then walking also well
9	MR	30	M	R	A	B. Mal	20 hrs	# B/B	O	TBW +	S++	S+	S+	Good		PTB cast on

								leg rt.		push pin	DF15 PF30	DF15 PF35	DF15 PF35			8wk & full weight bearing 10wk
10	AJ	22	M	L	A	L. Mal	6 hrs	-	C	Con		S+ DF25 PF40	S+ DF25 PF40	Good		
11	TL	25	M	L	A	B. Mal	5 days	-	C	Mall screw plate+syn desmotic	S++ DF15 PF30	S+ DF20 PF35	S+ DF20 PF35	Good		Synd screw removed on 8 wks
12	SN	12	M	R	Sl.	B. Mal	3 days	-	C	Con		S+ DF20 PF30	S+ DF20 PF30	Good		
13	JA	35	M	L	A	M. Mal	2 days	# Lower end radius	C	Con		S+ DF25 PF45	S+ DF25 PF45	Good		
14	RN	28	F	R	Sl.	M. Mal	6 hrs	-	C	Con		S+ DF20 PF40	S+ DF25 PF45	Good		
15	AK	19	M	R	Sp.	L. Mal	2 hrs	-	C	Con		S++ DF25 PF30	S+ DF20 PF35	Good		
16	JN	40	M	R	A	Bi Mal	6 hrs	-	O	K-wire	S++ DF10 PF20	S+ DF10 PF20	S++ DF10 PF20	Fair	Wound infectio n	K-wire removed on 6 wks
17	KL	45	M	L	A	M. Mal	8 hr	-	C	Con		S++ DF20 PF35	S++ DF20 PF35	Good		
18	BL	38	M	L	A	B. Mal	6 hr	-	O	k-wire	S+++ DF15 PF30	S++ DF15 PF35	S+ DF15 PF30	Good		K-wire removed on 8 wks
19	CT	35	M	R	A	Bi Mal	11 days	-	O	k-wire	S++ DF10 PF20	S++ DF10 PF20	S++ DF10 PF20	Fair		K wire removed on 6 wks
20	PC	33	M	L	A	L. Mal	3 days	-	C	Con		S++	S+	Good		

21	HM	26	M	L	A	Bi Mal	2 hrs	-	O	TBW+rus h pin	S+++ DF15 PF30	S++ DF20 PF35	S+ DF20 PF35	Good		
22	MN	55	M	R	A	Bi Mal	7 hrs	-	C	Mall-screw	S++ DF15 PF30	S+ DF20 PF35	S+ DF20 PF35	Good		
23	RK	28	M	L	Sl.	M. Mal	15 day	-	C	Con		S+ DF25 PF45	S+ DF25 PF45	Good		
24	MD	30	M	L	A	B. Mal	3 day	-	O	TBW+ rush pin	S+++ DF15 PF30	S+ DF25 PF45	S+ DF20 PF30	Good		
25	RJ	18	M	R	A	B. Mal	2 day	# B/B leg lt & Spinal #	C	Con		S++ DF20 PF30	S++ DF10 PF25	Fair		PTB cast on 6 wk full wt. Bearing 2 wk.
26	RT	35	M	L	A	B. Mal	8 hrs	-	C	Mall screw	S++ DF15 PF35	S++ DF10 PF25	S+ DF20 PF35	Good		
27	LL	23	M	R	Sp	M. Mal	8 hrs	-	C	Con		S++ DF10 PF20	S++ DF10 PF20	Poor	Non union limp+	Mall. Screw and bone grafting done
28	TK	15	M	R	Sl	L. Mal	7 days	-	C	Con		S++ DF30 PF45	S+ DF30 PF45	Good		
29	SS	45	M	L	A	L. Mal	2 days	# shaft hum. rt & # B/B leg rt.	C	Con		S++ DF10 PF25	S+ DF20 PF30	Good		
30	PT	17	M	L	A	B. Mal	5 hrs	-	C	Mall screw + rush pin+synd. screw	S++ DF10 PF25	S+ DF20 PF30	S+ DF20 PF30	Good		Syndesmotic screw removed on 8 wks.
31	BN	50	M	L	A	B Mal	8 hrs	# B/B leg Rt	C	Con		S++ DF10 PF20	S++ DF10 PF20	Fair		Pt. Wt. Bearing started at

												DF10 PF20	DF10 PF20			Bearing started at 10wks
32	RM	10	M	R	Sl	M. Mal	4 hrs	-	C	Con		S++ DF20 PF45	S+ DF25 PF45	Good		
33	DY	20	M	L	Sl	L. Mal	2 hrs	-	C	Con		S+ DF20 PF35	S+ DF20 PF35	Good		
34	JD	65	F	L	A	B Mal	4 days	Spinal #	O	TBW+ rush pin	S++ DF15 PF35	S+ DF20 PF40	S+ DF20 PF40	Good		Rush pin removed at 10 wk
35	DN	38	M	R	A	M Mal	5 days	-	C	Mall screw	S++ DF15 PF30	S+ DF20 PF35	S+ DF20 PF35	Good		
36	LP	39	M	L	A	B Mal	2 days		C	Con		S++ DF10 PF20	S++ DF10 PF20	Poor	Limp + deformi ty +	PTB cast at 10 wk & full wt. Bearing 6 wks
37	RJ	28	M	L	A	M Mal	1 day		C	Con		S++ DF10 PF20	S++ DF10 PF25	Fair		
38	CN	20	F	R	Sl	L Mal	5 hrs	-	C	Con		S++ DF15 PF30	S+ DF15 PF35	Good		
39	AK	35	M	L	A	B Mal	2 hrs	-	C	Con		S++ DF15 PF30	S+ DF20 PF30	Good		B/K walking cast on 6 wk for 6 wk more
40	RP	30	M	R	A	B Mal	8 hrs	-	C	Mall screw + rush pin	S+++ DF15 PF30	S++ DF15 PF30	S+ DF20 PF35	Good		

M- Male
C- Closed
F-Female
O-Open
R- right
TBW-Tension band wiring
L- Left
DF-Dorsiflexion
A-Accedental
PF-Planter Flexion
Sl-Slipping
S-Swelling
Sp-Sports
Con- Conservative

APPENDIX II-BIBLIOGRAPHY

Albers GH, De kort AF, Midendorf RP, van Dijk : Distal tibiofibular synostosis after ankle fracture. A 14 year follow up study. J Bone Joint Surg Br. 1996 Mar; 78 (2) : 250-2.

Anderson KJ, Le Cocq JF : Operative treatment of injury to the fibular collateral ligament of the ankle. J Bine Surg Vol. 36-A, No & July 1954.

Ashurst APC and Bromer RS (1922) : Classification and mechanism of fractures of the leg bones involving the ankle. Archieves of surgery; 4,5.

Bjornson RGB : Developmental anomaly of the lateral malleolus simulating fracture. J. Bone Joint Surg Vol, 38-A, No-1, January 1956.

Bonin JG : Injury top the ligaments of the ankle. J. Bone Joint Surg Vol. 1,47 B, No. 4 November 1965.

Bonin J (1950) : Injuries to the ankle, London. Henermen Medical Books Ltd.

Braunstein PW and Wade PA (1959) : Treatment of unstable fractures of ankle. Annals of surgery, 149, 217.

Brederveld RS (1988) : Immediate or delayed operative treatment of ankle, injury; 19: 436.

Burwell HN and Charnley AD : The treatment of displaced fractures oat the ankle by rigid internal fixation and early joint movement. J. Bone Joint Surg Vol 47-B, No. 4, November 1965.

Canale ST : Ankle lesions. Acta orthop Scand 46, 425-445, 1975.

Chandler RW : Management of complex ankle fractures in athletes clinics in Sports Medicine- Vol 7, No. 1, January 1988.

Chapman MW : Fractures and fracture dislocations of the ankle. The surgery of foot and ankle by Mann & Coughlin, 6th edition.

Chissel HR, Jones J : The influence of a diastasis screw on the outcome of Weber type-C ankle fractures. J Bone Joint Surg Vol- 77-B, No. 3, May 1995.

Colton CL : Injuries of the ankle. Watson-Jones Fractures and Joint injuries Sixth Edition. Published by B.I. Chinchill Livingstone.

Colton CL : The treatment of Dupuytren's fracture dislocation of the ankle. J None Joint Surg Br. Vol 53B, No. 1 February 1971.

Coonard RW, Bugg Jr : Trapping of the posterior tibial tedon and interposition of soft tissue in severe fractures about

the ankle joint. J Bone Joint Surg Vol 36-A, No. 4 July 1954.

Dias LS : Fractures of the distal tibial and fibular physes. Fractures in children. Vol 3, Rockwood Wilkins and Kind Second Edition.

Dijk CN, van, Lim Bossuyt PMM, Marti RK : Physical examination is sufficient for the diagnosis of sprained ankles. J Bone Joint Surg Br. Vol, 78-B, No. 6, November 1996.

Dijk CN, Van, Verhagen RAW, Tol JL Arthroscopy for problems after ankle fractures. J Bone Joint Surg Br. Vol 79-B, No. 2, March 1997.

Drez D, Guhi JF, Gollehon DL : Ankle arthroscopy. Clinics in sports Medicine-Vol-1, No. 1, March 1982.

Flemming JL, Smith H, Fracture : Dislocation of the ankle with the fibula fixed behind the tibia. J Bone Joint Surg Vol 36-A, No. 3, June 1954.

Greg JR, Das M : Foot and ankle problems in the preadolescent and adolescent athlete. Clinics in sports Medicine- Vol. 1, No. 1 March 1982.

Harrington KD : Degenerative arthritis of the ankle secondary to long standing lateral ligament instability. J Bone Joint Surg Vol. 61-A, No. 3, April 1979.

Hintermann B, gachter A, Lampert C : Arthroscopic assessment of ankle fractures. J Bone Joint Surg Br. 1995; 77-B, Supp II.

Huber M, Stutz P, Gerber C : Open reduction and internal fixation of the posterior malleolus with a posterior antigide plate using a posterolateral approach; A preliminary report. J Bone and Joint Surg, 1996.

Jensen SL et al : Epilemiology of ankle fractures in Aalborg a prospective study. Acta orthop Scand (Suppl 272) 1946; 67.

Kalkkonen A, Kannus P, Jarvinen M : Surgery versus functional treatment in ankle ligament tears (A prospective study) Clinical Orthopaedics and related research, Number 326. May 1996.

Kleiger B : The mechanism of ankle injuries. J Bone and Joint Surg Am Vol. 38-A, No. 1 January 1956.

Kleiger B : The treatment of oblique fracture of the fibula. J Bone and Joint Surg. Am Vol. 43-A, No. 7, October 1961.

Kotwick JE : Biomechanics of the foot and ankle. Clinics in sports medicine Vol. 1,No. 1, March 1982.

Kym MR, Worsing RA : Compartment syndrome in the foot after an inversion injury to the ankle. J Bone Joint Surg. Vol 72-A, No. 1, January 1990.

Olerud S : Subluxation of the ankle without fracture of the fibula. J Bone Joint Surg Vol. 53-A, No. 3, April 1971.

Ottosson L : Lateral instability of the ankle treated by a modified Evans procedure. Acta orthop Scand 49, 302-305, 1978.

Pallesen P et al : Treatment of malleolar fracture in Denmark. Acta Orthop Scand (Suppl 267) 1996; 67.

Pankovich AM : Fracture and dislocations of the ankle. Handbook of fractures by Clayton R. Perry et al.

Parrish TF : Fracture dislocation of the ankle. J Bone Joint Surg Vol. 41-A, No. 4, June 1959.

Pathi KM : Fracture dislocation of ankle in children. Indian J ortho Vol. 14, No. 2, December 1980.

Port AM, Mc Vie JL, Naylor G, Kreibich DN : Comparison of two conservative methods of treating and isolated fracture of the lateral malleolus. J Bone Joint Surg. Br. I, Vol. 78-B, No. 4, July 1996.

Rowley DI, Norris SH, Duckworth TA : Prospective trial comparing operative and manipulative treatment of ankle fractures. J Bone and Joint Surg Vol. 68-B, No. 4, August 1986.

Snell's : Clinical anatomy for medical student fourth edition.

Taylor JC : Fracture of lower extremity. Vol. 2. Compell's operative Orthopaedics Eighth Edition.

Tile ON (1987) : The rational of operative fracture care. New York, Springer vulag.

Trughber PD : Imaging of foot and ankle. Surgery of foot and ankle volume by roger A, Mann Sixth Edition.

Vegso JJ, Harmon LE : Non operative management of athletic ankle injuries. Clinics in sports medicine Vol. 1, No.1, March 1982.

Watson Jones (1955) : Fractures and joint injuries. Fourth Edition, Vol II.

Wilson FC : Fractures and dislocation of the ankle. Rockwood and green. Fractures in adults second edition.

Yablon KG, Segal D, Leach RE : Ankle injuries published by Churchill livingstone. Inc 1983.

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